Sewero La-ma-u – A Phonetic Approach to Literacy Teaching in Zambia

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Heinäkuu 2007

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Heinäkuu 2007
72 sivua, 5 liitettä

Lukutaidon ydin on kirjain-äänne vastaavuuksien oppiminen. Eri kielissä on erilainen foneettinen koodi, mistä syystä opetusmenetelmät eri maissa vaihtelevat. Tulokset, joiden mukaan lukemaan oppiminen on helpompaa läpinäkyvissä kielissä (suomenkieli) kuin ei-läpinäkyvissä (englanninkieli), viittaavat siihen, etteivät englanninkielelle tehdyt yleiset mallit lukemaan oppimisesta ole yleisesti sopivia muissa kielissä. Tästä syystä lukemaanopettamisen menetelmiä tulisi kehittää käytössä olevan kielen alfabeettisen koodin mukaisesti, ja malleja kehitystyölle tulisi etsiä samankaltaisista kielistä.

Läpinäkyvät ja ei-läpinäkyvät alphabeettiset koodit sekä analyyttiset ja synteettiset opetusmenetelmät kohtaavat Sambiassa, missä koulujärjestelmä oli englanninkielinen kolmen vuosikymmenen ajan, kunnes hallitus palautti käytännön opettaa peruslukutaito paikallisilla sambialaisilla kielillä, jotka muistuttavat suomenkieltä. Lukutaidon taso on Sambiassa edelleen matala huolimatta odotetusta helppoudesta oppia lukemaan kielillä joissa on säännöllinen ortografia ja kirjain-äänne vastaavuus.

Tässä tutkimuksessa kahdeksan tyttöä, joilla oli heikot lukemisen taidot, pelasivat opetuksellista tietokonepeliä joka harjoitti kirjain-äännevastaavuuksia Cinyanjan kielellä. Heidän oppimisprosessinsa tallennettiin tietokoneella ja analysoitiin yksityiskohtaisesti pyrkimyksenä etsiä mahdollisia selityksiä lukemaan oppimisen vaikeuksille.

Tulokset viittaavat siihen, että huolimatta uudesta kielikäytännöstä Sambian peruskoulussa, lapset silti oppivat englanninkielisiä kirjainten nimiä, ja kahden erilaisen alphabeettisen koodin sekaantuminen toisiinsa hidastaa heidän lukemisen taitojensa kehitystä. Lisätutkimukset ja opettajien ja vanhempien kouluttaminen sambialaisilla kielillä ja englanninkielellä tapahtuvan lukemaan opettamisen eroista ovat tarpeen, jotta lapsilla olisi paremmat mahdollisuudet saavuttaa Sambian kansalliset koulutukselliset tavoitteet ja kehittyä sujuviksi lukijoiksi kummassakin alphabeettisessa koodissa.

Avainsanat. Sambia, lukutaito, Ekapeli, tietokonepelit, kirjain-äännevastaavuuden harjoittelu

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ABSTRACT

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Master's thesis of psychology
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July 2007
72 pages, 5 appendices

The essence of literacy acquisition is learning letter-sound correspondences. Different languages have different phonetic codes which are why teaching methods in different countries varies. Findings that learning to read is easier in transparent languages (Finnish) than in opaque languages (English) have indicated that general models for reading acquisition made for English language are not universally adaptable to other languages. Therefore methods of literacy teaching need to be developed according to alphabet code of the language in use, and models for the development need to be searched from similar languages.

Zambia provides a setting where opaque and transparent alphabet codes and analytical and synthetic teaching methods collide. After three decades of all-English education, the government of Zambia revived the policy of giving primary reading teaching in Zambian Native Languages similar to Finnish language. Still, literacy levels in Zambia are low despite the expected easiness of learning to read in a regular orthography with one-to-one phoneme-letter correspondences.

In this study, eight girls with compromised native language reading skills played an educative computer game which trains letter-sound correspondences in Cinyanja language. Their learning process was recorded by the computer and analysed in detail with the purpose of finding explanations for difficulties in reading acquisition.

The results indicate that despite the new language policy in Zambian basic schools, children are still learning English letter names, and the confusion over two different alphabetic codes delays the development of their literacy skills. Further research, and educating teachers and parents about methodological differences of teaching literacy skills in Zambian Native Languages compared to English is required to improve the children's possibilities to meet Zambia's national educational standards and become fluent readers in both alphabetic codes.

Keywords: Zambia, literacy, Literate game, computer games, rehearsal in letter-sound correspondences

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1. Introduction

Children who fail to learn to read do so mainly because of environmental causes, not biological ones (McGuinness, 2004). Failure in reading acquisition can be a result of inadequate teaching. Reading is an essential skill in our world; therefore teachers have great responsibility to teach literacy skills efficiently and carefully so that maximum number of children would become fluent readers. Teachers, on the other hand, need adequate training for their profession and well designed curricula they can depend their work on. To teach someone to read requires profound knowledge about the process of reading acquisition.

Why is this knowledge about learning processes behind reading skills needed? Ehri & McCormick list three things: First, information about learning processes helps teachers to understand and interpret the word reading behaviours they see in delayed and disabled children. Second, information can clarify the locus of experienced difficulties the pupils have (e.g. various neuropsychological reasons for delay in reading acquisition). And third, information helps teachers to determine how to guide and support their pupils to develop further in reading (Ehri & McCormick, 1998). Information on learning process is also necessary for designing teaching methods and curricula that fills it purpose – teaches children how to read.

This study takes place in Zambia, a country where two alphabet codes (transparent local languages vs. opaque English) and teaching traditions (analytical vs. synthetic) collide. The basic assumption behind the study was that teaching methods are similar in similar language systems and therefore methods from highly transparent Finnish language could be transferred to Zambian Cinyanja language. In this study an educative computer game, originally designed to help Finnish children with reading difficulties, was translated to Cinyanja and used to help eight girls whose performance in literacy skills was below the majority of their peers. Even though Zambia has recently made profound changes in the education system, the children are still not learning to read as expected (Matafwali, 2005) and some children fail to overcome their reading difficulties (Kalindi, 2005). This study attempts to answer the most intriguing question: why?

1.1 Understanding the basic concepts of reading

Reading can be defined as the process of extracting and constructing meaning from written text for some purpose. Skilled reading entails online comprehension of meaning from running text (Vellutino, Fletcher, Snowling & Scanlon, 2004). McGuinness (2004) reminds that even though it is the words that carry meaning and message in speech and print, writing systems are not based on words, instead, all writing systems, living or dead, are based on phonological units of sound below the level of the word. Writing systems cannot be based on the whole word, because languages have too many words. A writing system is a code in which specific elements of a language are mapped systematically to graphic signs or symbols.

Alphabet is a writing system based on phonemes (speech sounds, i.e. individual consonants and vowels). Phonemes are the basis of writing system for all languages with highly complex syllable structure and inconsistent phonological patterns, like European languages (McGuinness, 2004). Phonemes are written (spelled) into print with graphemes. There are more speech sounds in most languages than there are letters in Roman alphabet, which is why some sounds need to be encoded with a combination of letters (digraphs) (McGuinness, 2004). Concept of grapheme includes both letters and digraphs that are used to symbolize speech sounds. The main point of a writing system is that the alphabet is a reversible code that is used to turn speech into print. What we call "spelling" (encoding) is the fundamental operation of turning sounds (phonemes) into symbols (graphemes, letters). What we call "reading" is decoding those symbols back into speech sounds to recover the words. To spell a word, you must first identify each phoneme in a sequence in your mind, remember how each phoneme in that particular word is spelled, and then write it down. What you can spell, you can easily read (McGuinness, 2004).

In order to master reading and writing, one must also understand the orthography of the language. Orthographic awareness refers to the sensitivity to constraints on how the letters in written words are organized (for example, in English, “vid” is legal, “xqr” is illegal) (Vellutino et al. 2004). In other words, orthography means standardized spelling and knowledge of legal and illegal writing (McGuinness, 2004). Orthographic awareness enables us to notice spelling mistakes in print and

recognise our own mother tongue in speech and print even when the words are not familiar to us. Orthographic awareness is often measured with reading or spelling pseudowords, words that do not mean anything but are structurally correct in a particular language.

Phonological awareness refers to ability to hear, remember and manipulate in mind a variety of sound units within words: syllables, syllable fragments (onsets/rimes) and phonemes (McGuinness, 2004). Phonological and orthographic awareness are reciprocally related cognitions that are both needed to form sensitivity to the regularities and redundancies characteristic of an alphabetic writing system (e.g., “at” in “cat”, “fat” and “rat” and “ing” in “walking” and “running” in English language) (Vellutino et al. 2004). Children who have difficulty in acquiring phonological awareness and learning to map alphabetic symbols to sounds will also have difficulty acquiring orthographic awareness (Vellutino et al. 2004). However, the importance of phonological awareness is smaller in so-called transparent languages (Holopainen, 2001). To put it simply, learning to read, or teaching someone to read, requires two things: one must have sufficient spoken language skill and know how the writing system of that language works (McGuinness, 2004).

However, how simple as it might sound, teaching phoneme-grapheme correspondences has not been the basis of literacy teaching for a very long time. For example, it was previously thought that readers memorize connections between the visual shapes of words and their meanings (“sight-words”) (Ehri & McCormick 1998). Early theories of learning acquisition assumed that children must learn the order of letters in words by rote memory and memorize every word separately with no role for phonological knowledge or generalisations (Alcock & Ngorosho, 2003). In fact, adequate facility in word identification depends heavily on the reader’s ability to acquire facility in alphabetic coding. To be more specific, because of the heavy load on visual memory imposed by the high degree of similarity characteristic of words derived from an alphabet (pot/top; was/saw), sight word learning depends on the child’s ability to acquire understanding and functional use of the alphabetic principle (Vellutino et al. 2004). That is to say, sight word reading is done by using readers' general knowledge of grapheme-phoneme correspondences (Ehri & McCormick, 1998). When readers acquire sufficient knowledge of the alphabetic system, they are able to learn sight words quickly and to remember them long term: any word that is read sufficiently often becomes a sight word that is read from memory (Ehri, 2005). In other words, automatic retrieval of letter-sound correspondences is the basis for sight word reading as well. This is supported by the growing consensus that the most influential cause of difficulties in

learning to read is the failure to acquire phonological awareness and skill in alphabetic coding (Vellutino et al. 2004).

1.2 Different languages have different challenges in reading acquisition

Reading acquisition and reading problems are not independent of the system of the connections between the spoken and the written system of the language (Lyytinen, Erskine, Aro & Richardson, 2006). Yet most research about development of reading ability has been conducted with children who speak English or a related Indo-European language (Öney & Durgunoglu, 1997). The most important models of alphabetic literacy acquisition are presented as general models of learning to read in alphabetic orthographies (Aro, 2005). These models are often based on English language, even though the main conclusion from the cross-language studies is that the development of literacy skills in English deviates from the majority of alphabetic orthographies. English is one of the least regularly spelled languages and any conclusions about spelling development must take this into account (Alcock & Ngorosho, 2003), in other words, whatever is said about reading in English, might not be universal, or relevant for other languages.

The problem with English originates from the fact that English represents five languages and their spelling systems superimposed on one another: Anglo-Saxon, Danish, Norman French, Classical Latin and Greek (McGuinness, 2004). According to McGuinness (2004) this makes English a very expressive language but has many deficits: there are 40+ phonemes in the English language and about 176 common ways to spell them. There are not enough letters in the alphabet for all the phonemes, for example, only 6 vowel letters for approximately 23 vowel sounds. Because there are not enough letters to encode the phonemes, digraphs (letter combinations) are used for a single phoneme. This complexity makes English an opaque language as there are multiple spellings for the same phoneme.

It is because of this complexity that reading in English has been taught in analytical way, from top to bottom, from whole words to smaller parts. For example, the expected process of learning in United Kingdom is described as 1) use and understand the organization of books, 2) knowing that words have a meaning and right direction of reading and writing 3) associating sounds with patterns in rhymes, syllables, words and letters 4) recognizing one's name and familiar words and 5) recognizing letters of

the alphabet by their shape and sound (European Commission, 1999). In general, reading instruction regimes in English put more emphasis on whole word recognition and less on phonological decoding abilities than in most of consistent orthographies (Landerl, 2000).

English is generally thought to be the most opaque alphabetic orthography, with complex and context-sensitive grapheme-phoneme pairings, multi-letter graphemes and inconsistencies (Lyytinen et al, 2006a). At the opposite end of the continuum are orthographies such as Finnish, Italian and Spanish, where the correspondences are more consistent, allowing reading acquisition simply by learning of letter-sound associations (Lyytinen et al, 2006a), and then inventing how assembling the sounds in the order of letters lead to an opportunity to identify words and their endless inflections typical to Finnish. Any written item pronounceable within Finnish alphabetic code can be read in Finnish independent of knowing the meaning. Thus children need not to know the meaning of the words before they can read them accurately, (although morphemes, which are valid in a spoken language, are identified faster and common syllables are soon read fluently) due to the instruction of synthetic phonics in schools which starts from letter-sound correspondences but moves soon to large units (Lyytinen, H. personal communication 3th July, 2007).

This difference between English and more transparent writing systems can be seen from the curricula of these countries as well. In Spain, teaching the grapheme-phoneme correspondences and teaching meaning of text appears simultaneously in the first cycle of primary education (European Commission, 1999). In fact, "identifying some very meaningful written words" is expected to happen before pre-primary education, and "working out by applying knowledge to the written code" is expected from age of 6 onward (European Commission, 1999, p. 113). In Italy, it is possible for teachers to choose whether they want to use analytical or synthetic approach to reading. Yet, "emphasis is placed on techniques specific to that mastery of the code" and that "graphic/phonic correspondences are presented as a preliminary step towards reconquering meaning". (European Commission, 1999, p.127)

Considering the complexity of English language, it is not surprising that cross-linguistic findings have consistently shown that, in terms of reading accuracy, English speaking children lag behind their peers who are learning to read in more consistent orthographies (Lyytinen et al, 2006a) The differences between reading in English compared to other languages was shown e.g. in a study made by Wimmer and Aro (2003). The results showed that at the end of Grade 1, the reading accuracy levels of German,

Dutch, French, Spanish and Finnish children were around 85%, and above 90% for Swedish children. The English children reached only 50% at that time and did not reach the accuracy levels of their Grade 1 counterparts until the end of Grade 4. For example, at the end of Grade 2, Swedish, Spanish and French children were already above 90% (and Finnish children at 89.6%) when English children had accuracy level of 71%. (Wimmer & Aro 2003). The English results were significantly poorer compared to the other languages at all grade levels.

In another study by Seymour, Aro and Erskine (2003) it was affirmed that the difference in acquisition of literacy skills in English and more transparent languages in other European countries, was not affected by gender or variation of ages at which children start school (Seymour et al, 2003). This excludes the possibility that children in some countries (e.g. in Finland) do better because they start the school at older age (age of 7 in Finland, age of 5 in UK) In this research by Seymour et al (2003) there was no significant difference between English speaking children and the Non-English in knowing letter-sound connections, but speed and accuracy of reading familiar words was much poorer in English sample than in the rest of the language groups. Same result was gained in reading pseudowords. It is also worth noting that comparisons between English speaking and other children were not held back by social disadvantage: the English participants were making excellent progress according to UK norms. Still, the rate of learning to read was slower by a ratio of 2.5:1 in English when compared to the other languages.

In addition to the studies already mentioned, English has proven out to be more difficult language to learn to read with (especially when traditional, non-phonic, teaching methods have been in use) than Italian (Thorstad, 1991), Turkish (Öney & Goldman, 1984), Greek (Goswami, Porpodas & Wheelwright, 1997) Welsh (Spencer & Hanley, 2003) and Hebrew (Geva&Siegel, 2000), the latest being most fascinating result as Hebrew was not even the mother tongue of the study subjects but nonetheless, learning to read was easier in Hebrew than with English. As Landerl (2000) puts it, there exists not a single empirical study that shows English children to be better in phonological recoding than children who use any other alphabetic orthography. The main conclusion is that even though handling phonemic segments and learning phonological recoding and decoding is the main challenge of reading acquisition, this challenge is much smaller when reading is learnt in a language with regular orthography (Wimmer & Aro, 2003).

1.3 Finnish methods of literacy instruction

Finnish is an example of an almost purely phonemic alphabetic orthography (Aro, 2005). The number of standard consonant phonemes is 13 (/p/, /t/, /k/, /m/, /n/, /l/, /r/, /s/, /h/, /j/, /v/, /d/ and /ŋ/) and the number of vowel phonemes is 8 (/i/, /e/, /ä/, /y/, /ö/, /u/, /o/ and /a/). There are three sounds that are used in loan words only (/b/, /g/ and /f/). Each phoneme is marked with corresponding letter except the phoneme /ŋ/ which is marked with N when short and with the digraph NG when long. All except /d/, /h/, /j/ and /v/ have two phonemic durations, long and short, marked with doubling of the corresponding letter. From the perspective of literacy acquisition, the Finnish orthography is in many ways optimal: 1) the grapheme-phoneme correspondence is perfectly regular, 2) number of phonemes is small, 3) graphemes are single letters, 4) consonant clusters are rare and, 4) phonemic structure of syllables is simple. (Aro, 2005) Learning to read in Finnish is so simple, that about 25% of children acquire the skill without any formal teaching (Holopainen et al, 2001).

The teaching of reading has always been done with synthetic methods in Finland. That is to say, starting with small particles (letters, phonemes) and continuing to syllables and finally words. Finnish is said to be synthetic language, where linguistic features are added to the core of the word (a car [auto], in the car [autossa]) which also makes it sensible to progress from bottom to up (Sarmavuori 2003). Child needs to have proficient implicit ability to manipulate small phonological units in order to learn all the variations of words which can have only one phoneme difference (e.g. “kodissa” [at home], “kodista” [from home]) (Lyytinen, Erskine, Tolvanen, Torppa, Poikkeus, Lyytinen, 2006). This is why teaching of letter-phoneme correspondences has such a big role in literacy instruction, and has led to the synthetic phonics approach, from smaller to larger units teaching. According to Sarmavuori (2003) the most common methods in literacy teaching are

1) *Letter method*, which is the oldest and uses the letter names (K = Koo). In this method children are taught to spell words using letter names (Koo, Ee, Äl > kel, Äl, Oo > lo, kello). This method is illogical and children are tempted to write words like “kooeeäläloo” instead of correct form “kello”.
2) *Phoneme method* uses only the actual phonemes (/k/, /e/, /l/ > kel, /l/, /o/ > lo, >kello) which is logical to the child as the connection with letter and phoneme is clearly visible. This method helps in learning to write.
3) *Syllable method* (or sliding method, Lerkkanen 2006) teaches first some phonemes, usually

some vowels and consonants which are then blended together so that pronunciation of phonemes is exaggerated and slowed down (keel – lllo). In this method only phonemes are used and letter names are avoided.

Also, method called KÄTS is also used, especially with children with learning difficulties. In KÄTS method phonemes are taught so that child pronounces them in the front of a mirror and observes how the sound is formed in his/her mouth. When phonemes and their equivalent letters are learned, children start combining phonemes into syllables. (Sarmavuori, 2003). In a study by Himmelä (1997) the usage of different teaching methods was surveyed in one major Finnish city (71 Grade 1 teachers). According to this research the most popular methods were ssyllable method 72% (44 teachers), phoneme method 39% and KÄTS method 39% (both 22 teachers). Most teachers (about 46%) knew and had tried the letter method at some point in their career but currently only one teacher was using it. Seven teachers (12%) used words in their teaching but nobody used whole language method. Teachers typically mixed teaching methods together. The most typical combinations of methods were phoneme & syllable and KÄTS & syllable.

The instructions to use the methods described above are given in teachers' manuals for initial literacy teaching, and they seem to be very beneficial in teaching to read in Finnish as it has been frequently shown that Finnish children are among the best readers in the world. In IEA Reading Study, 31 countries were compared around the world. The Finnish children (9- and 14-years old) showed highest literacy levels in almost all areas of the study even when Finnish children started school later than participants in most other countries (Elley, 1992[1]). Also, PISA survey both in 2000 and 2003 Finnish children performed best in the OECD countries even when children with special needs participated unlike in other countries (Pisa Finland 2006 website, accessed 27th June 2007).

Even in a highly regular orthography, like Finnish, roughly 6% of children have difficulties with reading acquisition and more than 3% have severe difficulties and may continue to read too slowly to facilitate the adequate comprehension of demanding text. Most of these children have a familial (genetic) background to their difficulties. (Lyytinen & Erskine 2006) The reading difficulties in

1 Other high performances in this study were USA, Sweden, France, New Zealand, Italy, Norway, Iceland, Hong Kong and Canada. Among the lowest performers were Venezuela, Indonesia, Trinidad and Tobago, Cyprus, Portugal and Denmark. This study took factors such as economical differences in consideration and also noted that even though countries like Botswana, Nigeria and Zimbabwe were among the lowest performers, children in those countries were reading in a non-native language.

Finnish language are related to length of the words and the coding of phonemic length (Aro, 2005). Naming speed and knowledge of letter names have been found out to be important factors in reading difficulties (Holopainen et al, 2001). As the literacy rate among Finnish adults is 100% (CIA World Fact Book, accessed 27th June 2007 [2]) it is obvious that everybody learns to read, the question is just how fluently. Finnish children attend preschool or kindergarten at age 6 and formal schooling and reading instruction begins at age 7 when they enter first grade in basic school (Lyytinen et al., 2006b) In a study that followed Finnish children entering the first grade, it was found out that children already knew about 16 out of 23 letters at school entry and over a third of the children read at an accuracy level of 90%. Children also read pseudowords more accurately in the beginning of formal reading instruction than the English speaking children did at the end of second grade (Aro, 2004).

The challenge of the Finnish education system is to provide sufficient support for dyslexic pupils. Dyslexia is a specific reading difficulty in reading that cannot be explained by general intelligence or lack of adequate education. Dyslexic children need more time and training to learn the basics of literacy. A Finnish pupil who does not learn to decode accurately by the end of first semester of first grade may almost unavoidably perceive him/herself different from others (Lyytinen et al. 2006b). Because the general learning speed at Grade 1 is fast, dyslexic children might feel they're inferior to others and are in risk of developing problems of self-esteem which may have a negative impact on their later education. This is why Finnish researchers have done plenty of dyslexia related research and developed diagnostic tests as well as remedial teaching methods so that dyslexic children could be provided with best possible support.

One of the most massive projects is the Jyväskylä Dyslexia Longitudinal project which has followed 200 children, half with familial risk of dyslexia and half of them without, from their birth to the school age and continues to follow them still (Lyytinen et al, 2006b). The findings from this research project inspired researchers to develop a remedial tool for children who have dyslexia or have a familial risk to it. The ultimate vision was to create a tool that children could use at home or at kindergarten already before school so that the deficits of dyslexia would be minimized. This tool took a form of a computer game called the Literate Game, and the goal of the game was to enhance the accuracy of processing for phonemic sounds and to learn to connect them fluently to their orthographic equivalent (Hintikka, Aro & Lyytinen, 2005). The approach behind the game development was that a computer-based training

2 According to CIA World Fact Book, there are only 9 countries in the world with 100% literacy (Andorra, Faroe Islands, Finland, Georgia, Greenland, Vatican City, Liechenstein, Luxembourg and Norway)

can easily reach everyone in need, irrespective of whether trained remediation personnel are available or not (Lyytinen, Ronimus, Alanko, Taanila & Poikkeus, 2007). Introducing the learning of letter-sound correspondences in a computer game context can make learning enjoyable and greatly assist those who are unable to master the connections without extensive repetition. The game adapts to the individual level of ability and this ensures that players are supported by maximum positive feedback and the child's interest in further playing is sustained (Lyytinen et al, 2006a).

The game itself has very simple idea: a child hears speech sounds through good-quality headphones and sees a selection of written symbols moving across the screen. Child tries to catch a symbol with mouse. If it was the correct one (“target”), child gets a score. If it was a wrong choice (“distracter”), the same target item comes again next time, so that the child gets a new chance to play that particular item. Items are repeated in different order and with different distracter options again and again until child is able to choose the correct symbols without any errors. The game is adaptable, which means that each child will get training on his/her true performance level. When the player is good, the game items will appear on the screen faster and with more distracters. A less skilled child will have a slower game with fewer options on the screen. Each game level introduces new items which get gradually more difficult until the child is able to play with real words.

The early pilot studies of the Literate game were promising: non-reading children acquired basic reading skill after less than 4 hours of playing (Lyytinen et al. 2007). Also, in addition to being an entertaining learning tool for children, the Literate game has other features. The game records everything the player does, giving the researcher an opportunity to analyse children's choices, error styles and general learning process all the way through. The development of this game continues still and it has been translated to several languages. At the moment Literate game is in wide use across Finland at homes, kindergartens and schools. Estimated number of users in the summer 2007 is about 30 000.

1.4 Zambian challenge: balancing with two different alphabet codes

As previously described, there are big differences in learning to read in opaque (e.g. English) and transparent (e.g. Finnish) languages, and that alphabet codes are language specific and need their own methods in teaching. Zambia, a former colony of United Kingdom, provides an interesting setting for research in this area. Like in many countries in Africa, there are many local languages in Zambia (72 dialects according to Linehan, 2004). Due to historical and political reasons, English has served as the lingua franca in the country. During the years 1966-1996 English was the language of education in Zambia (Linehan, 2004). English was the only medium of teaching, despite the fact that it was not the mother tongue of majority of the children. In 1996 the Zambian government made a historical decision that the initial reading skills in Grade 1 should be taught in a native language and that literacy in Zambian Native Languages should be a mandatory part of national examinations throughout the school. This new policy was called Educating Our Future (Linehan, 2004).

This decision was seemingly based on idea of preferring mother tongue over a foreign language in education, which is, also known to be beneficial to the children. Moreover, the change in the education program meant a radical change in the alphabet code: from highly opaque English to transparent Zambian Native Languages. There are 7 native languages included in the current education program: Silozi, Chitonga, Icibemba, Cinyanja, Kiikaonde, Luvale and Lunda (Ministry of Education, 2003a). Even though use of native languages has not totally erased the problem of mother tongue vs. unfamiliar language, it is worthwhile to notice that all Zambian languages use more or less the same alphabetic code.

At the moment it is difficult to acquire exact linguistic information about Zambian Native Languages and IPA[3] codlings were not found for this research. Therefore all descriptions of the nature of ZNLs are speculations unless a source is mentioned. Zambian Native Languages are originated from Bantu languages (Muhau, 2005) and are somewhat similar to Kiswahili, a language spoken widely in Eastern Africa. In Kiswahili, there are five vowel sounds and most syllables end in a vowel. Orthography is perfectly regular from grapheme to phoneme (Alcock, 2005). This seems to be true in Zambian Native

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Languages as well. Zambian Native Languages have one to one letter-sound correspondence but there are also complex syllable structures, like in words dzina, zithunzi, nyenyezi and such. The pronunciation of the phonemes is described in Appendix 5. All in all, Zambian languages are closely related, having a large proportion of the vocabulary in common, with similar structure, syntax, pronunciation and cultural proximity (Ministry of Education, 2000, p. 23).

The new education policy in Zambia is promising: first and foremost priorities for lower and middle basic education are to ensure that pupils master essential literacy and numeracy skills (Ministry of Education 2000, p.12). According to Curriculum Framework, essential literacy refers to the ability to read simple texts such as letters, local language newspapers, books and messages and the ability to write so that the pupil can express thoughts, ideas, events and messages in such a way that other people can understand them (Ministry of Education 2000 p.13). According to the Curriculum Framework, it remains a fact that a considerable number of pupils drop out after Grade 4. Therefore basic skills of literacy and numeracy need to be firmly rooted in the pupils by the end of Grade 4 (Ministry of Education, 2000, p. 29).

This curriculum acknowledges the need to reach full literacy in one language before starting a second language: “Initial literacy in Grade 1 must be taught in a familiar language. When the pupil has learnt to read and write in the most familiar language, the literacy skills shall be transferred to English (Ministry of Education 2000, p. 22)”. However, “apart from initial literacy the medium of instruction shall continue to be English” and “from Grade 2, Literacy shall be taught in English, while Zambian Language literacy skills continue to be enhanced” (Ministry of Education 2000, p.23) which means that majority of education is still given in English. Zambian Languages are an examinable subject at the Grade 7 examinations (Ministry of Education 2000), which requires fluent performance in both languages in order to graduate from basic school. The current curriculum puts much pressure on Grade 1: children must learn to read and write in ZNL fluently, if they wish to transfer their literacy skills to English literacy. After that they must be able to continue improving their ZNL literacy skills even when the majority of instruction is given in English and only maximum of five hours per week are reserved for ZNL language. The curriculum sees the challenge as well: “unless the child learns to read and write properly during the first two years, learning further up the educational scale becomes increasingly difficult and traumatised” (Ministry of Education 2000, p.13).

Table 1: Core curriculum for grades 1-4 in Literacy, Zambian Language and English (Ministry of Education 2000)

Grade	***Literacy***	***Zambian Language***	***English***
Grade 1	5 hours/week Listening to read and write in a ZNL and use a computer	3 hours/week Listening, comprehension, vocabulary, oral expression	2 hours/week Listening, comprehension, vocabulary, oral expression
Grade 2	5 hours/week Learning to read and write in English and use a computer	4 hours/week Listening, comprehension, vocabulary, spoken and written expression, reading	2,5 hours/week Listening, comprehension, oral expression
Grades 3-4	5 hours/week Reading in English and Zambian languages: Consolidating literacy skills in English and Zambian Native Languages and use a computer	5 hours/week Listening, comprehension, vocabulary, spoken and written expression information gathering. Giving and following instructions. Awareness of similarities between Zambian languages. Zambian culture	3 hours/week Listening, comprehension, vocabulary and oral expression. Life skills, learning and thinking skills. Information gathering, giving and following instructions.

This new approach to literacy teaching includes a course called New Breakthrough to Literacy (NBTL), which is taught for one hour per day (Lineman, 2004) and was published in year 2000. According to Lineman, “the strategy at Grade 1 is to fast-track reading and writing skills while building up to a level of spoken English that will allow the skills developed in the local language to transfer to English at Grade 2” (Lineman, 2004, p.5). The first pilot of the program was successful: children in Grade 1 were reading and writing at levels equivalent to Grade 4-5 compared with children on traditional teaching (Lineman, 2004). It is however, worth to point out that in the Baseline Reading Study that was carried out in year 2000 for measuring the effects of the new curriculum, the tests included e.g. a free writing test in which pupils in Grade 1 were asked to write their name and the name of their school, and pupils in Grade 2 were asked to write two short sentences about themselves (Kelly, 2000, p. 10). Also, the scoring of the writing test was scaled so that pupils scored 0.5 or 1 point if per word if the word was “misspelt but readable” (Kelly, 2000, p.34). This indicates that the expectations for children's performance are still rather low.

The NBTL program is based on Language Experience Approach and includes phonics, syllabic, look-and-say and “real books” (Ministry of Education, 2003a). NBTL-project states that the expected

outcome for the Grade 1 is that learners should demonstrate understanding and knowledge of the writing system of their language knowing that letters make up words and words make up sentences (Ministry of Education, 2003, p. 1) The program begins with familiarising children with drawing, using of symbols, learning the left to right orientation, and other similar activities which are certainly good for children who may have never seen books or used a pencil before. The program continues to teaching pupils how to write sentences using word cards and how to copy letters. In Stage 1 the only material about letters relates to copying letters from the model and finding two similar letters from the paper. At the end of the first stage pupils start working with sentences which relate to posters in the class room. This is done by repeating the sentences after the teacher and compiling them using word cards. Pupils are supposed to read the words in the cards from memory. They are also taught to copy words from a model and recognise words such as "crying" and "uncle"[4] by drawing a line from a picture to the written word.

Within a month children start Stage 2 in which learners are promised to be able to "read some of the simpler story-books from the class library" and around the same time "read and know the sounds and syllables of a minimum of 10 phonic posters" (Ministry of Education 2003a, p.77). On week three on Stage 2, teachers are instructed to "start introducing the 5 single vowel posters, then select a different phonic poster each day and try to link it to the sentences you will be covering in the teaching corner" (Ministry of Education, 2003a, p.95). At the end of the final stage of the program, children "should be able to read all the readers with understanding and fluency, write both functional and creative texts with appropriate punctuation and take dictation of at least three sentences" (Ministry of Education, 2003a, p.14). All this suggests that the literacy teaching is done by using analytical methods typical to teaching literacy in English.

The NBTL course for Grade 2 sets outcomes for the first stage so that learners will "read the 58 words and sentences for this stage... recognise and write all the letters of the alphabet in English... sound out most initial beginning consonant sounds in English" (Ministry of Education, 2003b, p.19). The Teacher's Guide for Grade 2 also includes short instruction to phonics, explains some basic differences between English and Zambian Languages and discusses the irregularity of English pronunciation. The guide also includes a pronunciation table of English sounds using example words and remarks such as "there are also words in English that begin with letter C that sound like S (like city and circle).

4 The teacher's manual uses English words as examples and gives a separate core vocabulary in each of the seven ZNLs

Learners have to learn which is which. You cannot teach them all the rules and exceptions" (Ministry of Education, 2003b, p.38). The methods of phonics teaching or pronunciation of Zambian Native Languages is not explained in the Teacher's Guide for Grade 1. It seems that the NBTL programme is paying little attention to the essence of reading acquisition: learning letter-sound correspondences.

The follow-up for the Baseline Reading Study has not yet been done. However, some studies about the effects of NBTL -program exist. One study reported that Grade 3 pupils who had participated in PRP programme had relatively better reading skills in Silozi than Grade 5 pupils who had started their schooling in English (Muhau, 2005). However, other studies have indicated that the new curriculum has not reached its goals. In a study by Matafwali (2004) 106 randomly selected pupils on Grade 3 who had gone through NBTL/PRP program, were tested for their English literacy skills. The results were startling: Only 42.5% were able to recite all the letters in English alphabet, 46% were able to name the letters of alphabet and 61% were able to identify them. Even more alarming was the result that only 11% were able to relate letters to their appropriate sounds and only 29% were able to relate given sounds to appropriate letters. Also, only 19% were able to successfully blend sounds into words, 35% could not read two letter words, 26% could not read one syllable words and almost half were unable to read two syllable words (45%) or three syllable words (49%). This performance was rather far from the Grade 3 ideal of being able to "write at least two short sentences about a picture" (Kelly, 2000, p.10). Another study was made on 60 poor readers (identified by teachers) in Grade 2 who had participated in a NBTL class. Only 13% could read two syllable Icibemba words, only 8.3% knew 20 alphabet letters and 90% of them knew four or less phonemes (Kalindi, 2005). These studies indicate that despite the reform of the curriculum, Zambian pupils are still performing under the expectations and far too many are in risk to drop out of school without learning the basic literacy skills.

1.5 Research questions

The purpose of the present study was to explore possible underlying factors behind the literacy situation in Zambia. It is intriguing that even though the Zambian Native Languages are just as transparent (in other words, easy) as Finnish, and the new policy for initial literacy teaching promotes learning in a Zambian native language, the learning results are still far from what they could be. Zambian children are expected to learn just as much and just as fast than their peers in Finland. Failing to acquire basic literacy skills during the Grade 1 has traumatic consequences in both countries. These factors led to the idea that remedial tools made for Finnish children with reading difficulties could be beneficial to Zambian children as well. Also, the Zambian Curriculum mentions the use of computers as one of the educational areas which matched nicely with our intervention method.

Considering the overall situation in Zambia, it is evident that there is a need for efficient teaching method of initial literacy skills, especially for those who either have difficulties in acquiring reading skill due to biological reasons (dyslexia), or have other reasons of not being able to have sufficient opportunity to learn to read and reach literacy on average speed (e.g. due to lack of opportunities to access written materials and practise reading skills). Based on the information about the current curriculum, it is likely that the children who need this support most are those who are going to start or have started already literacy in English: if children have problems with ZNL Literacy at this time, it will be very demanding for them to become aware of the differences between of these two alphabet codes. Also, more information is needed to explain why Zambian children do not learn as well as they by could be learning, considering the letter-sound correspondences and orthography of the Zambian Native Languages. These objectives give us two main research questions. Could an educative computer game benefit Zambian children and improve their basic literacy skills? And, what does the game reveal about the possible explanations for the children's low performance in literacy?

2. Methods

This study is a sub-study of a larger research[5] which was conducted in autumn 2005 in Lusaka, Zambia. As a whole, there was a sample of 1300 pupils from Grades 1-4 in three public schools whose literacy skills were studied either in Cinyanja or in English. In addition to these, one study was made in a private international school. The overall purpose of the research was to gather data of benefits of the Literate game in Zambia and to observe the learning process and special characteristics of reading difficulties in Zambian children. The main aim of the research was to find ways to support the current curriculum and provide new possibilities to improve the quality of literacy instruction and introduce a method of remedial teaching for children who have compromised reading skills. This particular study concentrates on case stories of 8 participants, and the observations that can be made from their learning and effectiveness of the pilot version of the Zambian Literate game (Sewero La-ma-u) which was developed for this study.

2.1 Participants

In July 2005, 75 Grade 1 pupils and 65 Grade 2 pupils were screened for reading problems in a girl school located in Lusaka city centre. According to oral information from the school teachers, English was not taught in the Grade 1 but the school did not use the NBTL programme either as they had not received the materials yet. Based on the spelling test (see Appendix 1) results, a cut-off limit for 15% test score was estimated grade-wise for finding those with most urgent problems. The cut-off limit for Grade 1 was 1 point, meaning that all children with 0-1 were selected as potential participants. The cut-off limit for Grade 2 was 2 points, so all children with 0-2 formed the potential participant group. Originally it was planned to have at least 10 players from both grades but due to the fact that intervention period took place very close to Christmas holiday, many children did not play long enough and had to be excluded from the data[6]. The children in this final study subject group were the ones with longest intervention times. Children were asked to pronounce the phonemes after the computer. The computers which were used in the intervention were donated to the school.

5 Other studies from this project are being prepared by Kachenga, Mando, Kaoma, Chilufya, Kalindi and Matafwali

6 One child was excluded because she did not understand the game, one because of erroneous scoring in the spelling test and one because she did not have anything to learn in the phoneme levels.

Table 2: Participants of the study

Name	*G.*	*Language*	*Intervention days*	*Playing time*	*Trials*	*Highest level*
Rudy 791	2	Icibemba	12	201 min	3569	13
Mary 789	2	Citonga	8	175 min	2842	14
Edna 831	2	Citonga	12	164 min	2781	24
Dinah 841	2	Cinyanja	13	129 min	2643	9
Ally 844	2	Cinyanja	11	157 min	3297	15
Lily 1538	1	Silozi	11	107 min	1994	5
Oprah 848*	2	Cinyanja	13	125 min	2327	13
Wendy 843	2	Icibemba	9	93 min	1768	8

G. = Grade. * Oprah's computer broke at the end of the intervention, so she was transferred to another computer, but for technical reasons it was not possible to record her performance during the last three days of intervention. The number of intervention days is correct but other measures have only records from ten days, and Oprah's case story is based on this data.

The case stories describe each child's intervention in detail. The case stories present background information, the initial literacy skills, learning process and the outcome of the intervention. Children's performance in the Spelling tests is described qualitatively. Similarities between the children are discussed in the summary of the results.

2.2 Sewero La-ma-u – The Literate game in Cinyanja

A Cinyanja translation of Finnish Literate game (Ekapeli) was designed for this study. Cinyanja was chosen to be the language as it is commonly spoken in Lusaka city area (42% in the whole Zambia, Webb & Kembo-Sure, 2006b). The original Finnish game (version 40.143beta) was modified for this study as follows:

a) The contents of the game, the written stimuli and the main structure of the program, were kept as close as possible to the original Finnish version so that comparisons (if needed) between Finnish and Zambian playing would be possible.
b) The game items (letters, syllables and words) were changed to match Cinyanja alphabet system and vocabulary. This was done with expert help from Curriculum Development Centre.
c) The game sounds were recorded using a Zambian speaker who vocalised phonemes, syllables and words in Cinyanja. The spoken instructions in the game were also spoken in Cinyanja. Cinyanja items were chosen so that they represent the most typical aspects of the language.

The game was titled Sewero La-Ma-U ("Game with Words") to promote the importance of using Zambian language. The game involved 25 Levels: levels 1-6 introduced all phonemes used in Cinyanja, levels 7-18 trained syllables and levels 19-25 trained words, starting with 3-letter words such as U-KA and O-NA, then 4-letter words like TA-TE and GA-LU, then 5-letter words (PHA-LA, MA-NJA), 6-letter words (MI-SI-KA, MA-KO-LO) and 7-letter words (NYE-NYE-ZI, KU-MBU-KA). The very last level had a small selection of 5 letter words which were introduced in pairs and which had one phoneme difference (MVEKA/MVERA). See Appendix 2 for full list of game contents.

The game version had two technical deficits. The items in the game were presented only in one or two levels which mean a) the exposure time to particular items was short and b) target items had only few distracters. The latter means, that for example letter I was used in the game only with A, T, N, S, E and L and therefore, we can only know whether or not the child knows the difference of I and these mentioned phonemes, but we have no information on the child's ability to know difference between I and P, R, C or any other letter that was not presented with I. Regardless of these deficits, this game version was chosen for this study as it would have been too risky to try to change the code of the game and pilot new contents at the same time.

On the other hand, this game version was much stricter than many other versions because it did not allow a child to go further in the game before 100% performance on the particular level was achieved. 100% performance is reached when the child makes correct choices three times in row. If child makes a mistake after two trials, the counting of three subsequent correct choices starts again. This means that the child has to recognise the asked target item at least three times without errors, no matter which of the distracters in the given level is presented with it.

2.3 Assessment methods

The reading skills were assessed with a spelling test. The Spelling test had 20 items: 5 letters, 5 syllables, 5 three-letter words and 5 four-letter words. The test was designed by Zambians and based on the estimated performance level of the children, e.g. it was expected that children on Grade 1 should know the letters and be able to blend sounds into syllables, and Grade 2 children would be able to write short words. It was expected that the very best Grade 1 pupils would get 10 points and the best Grade 2 pupils 20 points. Phonemes were asked in Cinyanja and the children were expected to write the

corresponding letter. It was also stressed out in the instructions that the children were supposed to write in Cinyanja. Instructions were given in Cinyanja and English. The test was performed either by the class teacher or by a Zambian assistant. The pre-test word order was used in the July screening and October pre-test, and the post-test word order was used in December post-test and January follow-up. By the time of the follow-up test, the children had been two weeks at school and started a higher Grade level. The tests were conducted mostly in small groups because children were often absent from school and needed to be tested when they happened to be available. See Appendix 1 for full contents of the Spelling test.

2.4 Gamelog analysis

As it's been previously mentioned, the Literate game records everything the player does on the computer. These so-called gamelogs can be analyzed with several computer programs which each have different features and methods of measuring. The general way of interpretation in this study is that 60% performance is equivalent to guessing and performance at or above 95% is considered to be a sign of real knowledge. The performance level is set this high because the items in this study are phoneme-letter correspondences which are supposed to be automatic.

2.4.1 Graphotable

Graphotable is a program which summarizes the playing process into percentage scores. Graphotable counts right and wrong answers from each trial in each playing session, and this information gives us statistical information on child's performance. Graphotable was developed by Kimmo Teerimäki. In this study Graphotable is used in following ways:

1) To get another perspective on child's knowledge of sound-letter correspondences. In the Spelling test the child was asked to write items, whereas in the game the child is asked to choose an item after hearing the sound, that is, to recognize an item. The Graphotable's “First playing session score” gives us information on the child's first reactions to the game items. For example a score 4/4/100% means that an item was asked for 4 times and the child gave a correct answer every time. The Graphotable first playing time performance is usually reported only with the performance percentage, as there is no variation in the trial numbers. The child's

passive knowledge of the alphabetic code is reported based on these first session 100% performances, e.g. child knows 16/24 phonemes.

It is worthwhile to remember, that first session score always refers to several trials of asking a certain target, and that the game has given feedback about right and wrong answers. Therefore first session scores 44% means that despite the feedback the child has persistently given the wrong answer. It should also be remembered that "first playing session" means the first playing session during the recorded intervention, not the first time ever that the child tried the game. All the children played a while without recording to make sure they understood the game and were able to use the mouse and other equipment. The lowest first time session scores are mentioned in the "learning process" section of the case stories as they were the items the children were supposed to practice in the game. The first time session score answers to question "what did the children know beforehand?"

2) The Graphotable "total playing time score" is used for listing the phonemes the players played with 95% or 100% accuracy throughout the whole game intervention. These top performance scores are listed in Appendix 4 which gives a general view on the items children experienced to be easy. The total playing time is also used in the outcome section of the case stories to give a better estimation of easiness or difficulty of a particular item. For example, it is possible that the child had problems in the first playing time score (i.e. 56%) in an item but the total playing score is actually 90%. On the other hand a child can do perfectly according to the first playing score but the total performance is only 70%. The total playing score gives a wider perspective on the player's performance. The total playing score is reported in form Right answers/Trials /Performance, e.g. 12/14/85%. Total playing score answers to question "what was easy or what was difficult" during the whole intervention, but it does not reveal progress or development within the game.

2.4.2 Overview

The Overview program is based on Bayesian probability mathematics and is developed by Janne Kujala. The Overview program makes a time line of the player's intervention and starts a new graph each time a new item starts in the game. It is possible to see several things about an item. First of all, you can see the mean performance line in the center of the graph. This thin line is at the bottom of the graph when the performance is poor and rises to top side when the player does well. When the line is in the centre of the graph, the real performance levels cannot be confirmed. Second, you can see the right (green) and wrong (red) answers in the graph (or, dots on bottom or top side of the graph). You can see if the mistakes have happened in the beginning of the time line, or if they're just scattered around. You can also see if a sudden appearance of mistakes (and drop of the performance line) happens at the same time with introduction of new items. The Overview pictures are very large and it is possible to show only selected details about players' graphs.

In this study Overview is generally used to describe the learning process in time: what happened first, how long it took to make progress, was there anything surprising in the process, did the player reach the top performance level at the end of the playing etc. Overview answers to the question “what happened during the intervention”. The Overview information is used in “learning process” section and also in the “outcomes” to give details about player's performance[7].

2.4.3 Levelscores

When the previous programs show learning item-wise, Levelscores shows the player's performance level-wise. Levelscores draws a simple graph of the performance percentages of playing sessions on each level. This graph illustrates how easy or difficult it has been for the player to get through a level. The Levelscores are summarized in Appendix 3. The Levelscores answers to question “which sets of items were easy or difficult”. It was assumed that the game is easy in the beginning and get more difficult in later levels. Levelscores shows if this happened or not and it also shows individual differences between children's playing experiences: some levels were easy for somebody, while other levels were difficult. Even though this study only concentrates in phonemes, the Appendix 3 has information on the full playing process, including the syllable and word levels when they were played. In the case stories the easiest levels are mentioned, and the most difficult levels as well, if the information is relevant in the case.

7 There is some inconsistency between Graphotable and Overview programs: Overview sometimes shows a mistake when Graphotable says the performance has been 100% correct. As it is not known at the moment which program is more precise, results from both programs are reported.

2.4.4 Daisygraph

Daisygraph answers to the most important question: is the child able to connect the right sound to the right symbol? Or more simply “why did the child make a mistake”. Daisygraph shows how well or bad the player has known the difference between the target and the distracters. There are four circles in the figure which represent 0%, 50%, 75% and 100% performance levels. Each target-distracter pair makes its own tiny “petal” to the graph, which shows the probability of understanding the difference between these two. When the player prefers the distracter, the petal is very near the center of the picture presenting 0% or 50% performance. When the player is choosing the target item correctly, the petal is near the outer 100% performance circle. The petals are colored so that green refers to good performance, red to bad performance and brownish to mediocre. Daisygraph is developed by Janne Kujala. In this study the Daisygraph makes a probability petal for each 20 trials of a target-distracter pair. Because of this, it is possible to see the development of player's performance when there are more than 20 trials. The small numbers outside the Daisygraph tell how many times the distracter has been presented with the item. Usually trials less than 5 are meaningless because there's too little material for calculating the probabilities of performance.

3. Results

3.1 Rudy 791

Rudy is 8-year-old 2nd grade pupil whose mother tongue is Icibemba. Rudy played the game for 12 days and the total playing time was 201 minutes (3569 trials) reaching level 13 in the game. As previously mentioned, subjects were given a spelling test four times during the study in which they were asked five letters: A, I, D, B and M. In a screening test in July Rudy wrote A and M correctly, and in November pre-test she was correct with A, M and B. In both tests prior playing, she wrote E when I was asked and didn't give any answer to D.

Initial literacy skills

Based on Graphotable first session records Rudy recognized 17/24 letters (A, B, C, H, I, J, K, L, M, N, O, P, R, S, U, V, Z) which were known 100%. Among these items there were eight, which were 100% in total playing time, meaning that Rudy has not made a single error with them in the whole game. See Appendix 4 to see the targets and distracters. Based on Overview, Rudy has played targets K, Z, O, P, C, R, J and B without errors. Levelscores statistics (see Appendix 3) shows that Rudy has passed Level 3 (T L E K U Z O) and Level 6 (J H Y T D B V) on the first attempt.

Learning process

According to Graphotable first session scores, targets under 100% were D (80%), G (75%), T (80%) and Y (75%). Targets under 70% performance level were E (57%), F (66%) and W (66%). These were the items Rudy needed training with. Overview gives us a wider picture of the process. There have been only 1-3 errors with U, M, D, F, G, W and Y. In cases of D, F, W and Y the errors have happened at the very beginning of playing, or the playing time with these items has been too short to confirm the real performance level. After initial problems, targets D and Y have been played almost perfectly. Also, there have been some errors with U that have happened when U has been played with new distracters. The few errors with M and G are not connected to simultaneous appearance of new targets. In any case, Rudy's performance has been good enough for fast progress.

However, Overview reveals that there has been something wrong with Level 2. The first level with A,

I, T and N has been played rather nicely, with some errors with T in the beginning and A in the middle of the time line. Level 1 has been passed quickly on the first playing day, but Level 2 has been a difficult struggle. Targets L and S have been okay, with some random errors, but E has been a problem right from the start. Also, it can be seen that eventually Rudy starts to fail previously known targets like A, N, L and even well played T as well. Luckily, Rudy has got plenty of playing time on fourth intervention day and she has overcome her difficulties. After that, Rudy's progress in the game is almost vertical. It is worth pointing out, that when target E has been played in the Level 3 (T L E K U Z O) with different distracters, there has not been errors with it.

The process shown in Overview explains the total playing results from Graphotable which show that the most difficult targets for Rudy were F (7/9/77%), W (9/77%), E (100/126/79%), I (119/146/81%), G (6/7/85%), U (15/86%), A (111/125/88%), L (94/104/88%) and N (105/119/88%). It seems that the low total scores with F, W, G and even U are possibly due to very few trials, whereas targets E, I, A, L and N have been played over 100 times during the Level 2.

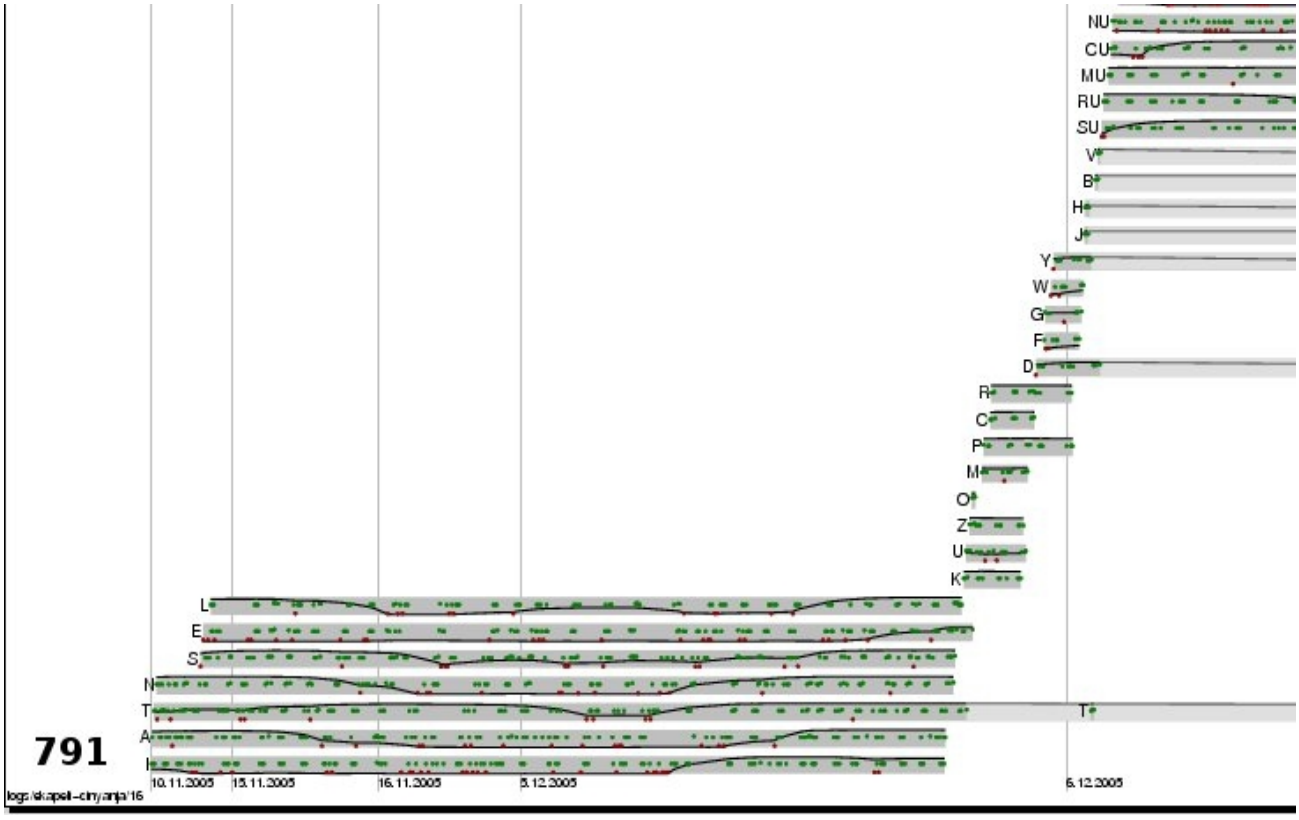


Illustration 1: Rudy 791 Overview detail. Difference between performance in Level 2 and subsequent phoneme levels.

Daisygraph shows us why targets I, E and A have been difficult. First of all, target A has been mixed

with distracter I but has been learned during the last 20 repetitions. Target E has been mixed with distracter A, and despite of 29 repetitions the results are still around 60% area, although showing little progress during the last 9 trials. Target I has been mixed with distracter A and with 116 repetitions Rudy has reached about 90-95% performance. And also, target I has been mixed with distracter T and remained between 60-70% after 19 trials. Note that due to random appearance of game items, E and I have not been presented in the same trial at all, and yet according to test results and observations, that was Rudy's most obvious problem.

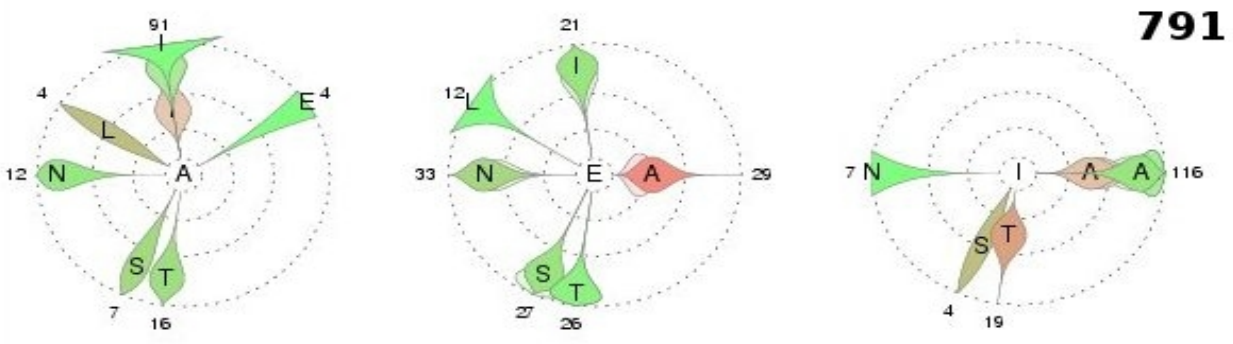


Illustration 2: Rudy 791 Daisygraph detail showing difficulties with targets A, E and I.

Outcome

In the spelling test before playing, Rudy knew A, B and M. There was no difficulty with M or B in the game, but target A was initially mixed with distracter I. In the spelling test, Rudy wrote E when I was asked. All analysis programs show that Rudy had problems with phonemes E and I. However, when E was the target and I was the distracter there were no major problems with them. It is interesting that appearance of targets I and E in the same level (Level 2) resulted as relapse in previously known targets as well. In the spelling test Rudy did not know D, which was not initially known in the game either but was learned quickly within 5 trials. According to Graphotable, Rudy played targets D, G, T, Y, E, F and W under 80% accuracy in the first playing session. According to Overview, items D, Y, E, G and T were eventually learned but there were too few trials with F to confirm the performance. Subjects were tested on the last playing day in December. In this post-test Rudy knew M and A, but wrote still E when I was asked. A month after the last playing day, subjects were given a follow-up test. In this test Rudy was trying to make syllables which included the target letter in them like writing “ma” instead of M and did not get any items correct.

3.2 Mary 789

Mary was an 8-year old 2nd grade pupil whose mother tongue was Citonga. Mary came to play on 8 days and reached Level 14 (2842 trials). In July screening she wrote A and MA correctly but failed in I (wrote E) and IMA (wrote EMA). In pre-test she wrote correctly all letters B, D, I, M and A, but wrote "mothr" instead of AMAI (amai means mother). She was an active girl with enthusiastic attitude towards playing. She vocalized phonemes sometimes.

Initial literacy skills

According to Graphotable first playing session records, Mary has recognized 19/24 targets (B, C, D, E, F, G, H, I, J, L, P, R, S, T, U, V, W, Y, Z). Out of these, there were 10 that were 100% in the total playing score and 4 at or above 95% in total playing score (see Appendix 4). Based on Overview T, S, L, Z, R, D, G, H and B have been played without any errors. The Levelscores statistics (see Appendix 3) shows that Mary has passed Level 2 (A I T N S E L), Level 5 (P R D F G Y W) and Level 6 (J H Y T D B V) on the first playing time.

Training process

According to Graphotable Mary has not known targets A (50%) and K (66%) on the first playing time. Also M, N and O have been known with 80% score. These were the items she needed training with. Overview shows us, that there's has been challenge with target A. It seems that in the beginning of the time line Mary made consistently wrong choices, and that Mary learned target A in the beginning of playing on her third intervention day. On the other hand, other items in the Level 1 have been played perfectly right from the start, save one error with N. According the Levelscores, it took six times for Mary to pass the first level. Second level has been passed quickly on first playing time. There has been an initial problem with K in Level 3 while other targets have been played well. It has taken two times for Mary to pass this level. In Level 4 her playing with U suddenly relapses despite a very good start with the item and stays low till the end of the time line. Last two phoneme levels are passed on first attempt without any problems.

According to Overview and Levelscores Levels 1 and 4 have been the most challenging in the

phoneme levels. Daisygraph provides possible explanations. With target A, there has been confusion with distracter I and only during the last 4 trials Mary has reached about 90%. Target A has been presented with distracter E for two times at it seems that Mary has given a wrong answer both times. However, two trials are too little to draw any conclusions. Target U has been mixed up with distracters K and M and never really learned to distinguish from them. The performance remains around 60%.

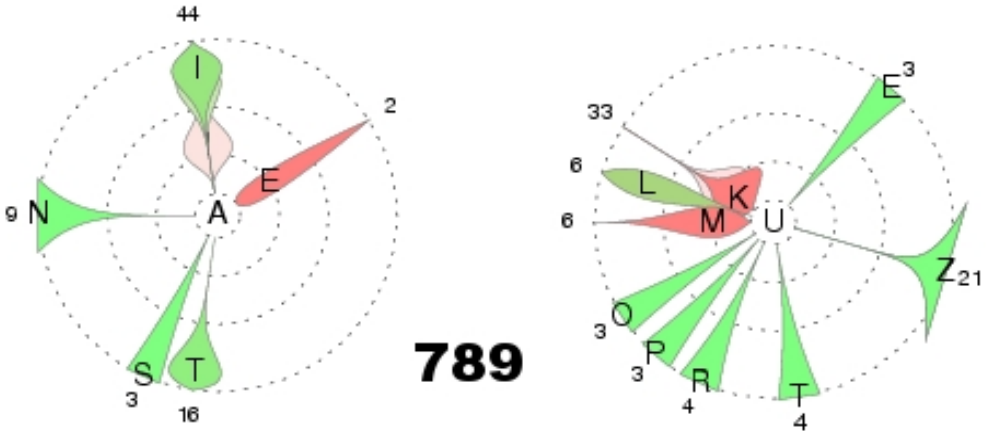


Illustration 3: Mary 789 Daisygraph detail showing performance with targets A and U.

Outcome

In both tests prior to playing Mary was using letter E when I was asked. According to Graphotable, Mary needed training with items A, K, M, N and O. According to Overview, her performance with target A relapsed after a while of good scores and remained low when Level 2 was played later on during the intervention period. There was also some fluctuation with target N but the final performance stayed on the upper side of the graph. Target M remained little below the top levels throughout the

game, but performance with target O was stable after being learned. According to Graphotable the overall performance with target K was 40/44/90%, target M 23/26/88% and target N 42/47/89%. According to Graphotable, the most difficult items in the total playing time were U (50/73/68%) and A (54/68/79%).

Mary was a good player and proceeded fast in the game. However, there was an incident when she started playing with syllables (Level 7). After one of the failed games Mary's understanding of the items was checked by asking her the beginning sounds of the syllables on the screen. She answered that SU starts with /e/ and RU with /a/. The vowel U was very difficult for Mary in the phoneme levels so the insecurity with it could also explain her mistakes in Level 7. In December post-test she wrote only A correctly and in January follow-up she wrote MA right.

3.3 Dinah 841

Dinah was 8-year-old 2nd grade pupil whose mother tongue was Cinyanja. In July screening she didn't score at all but in November she wrote B, D and A right, but wrote E instead of I. Dinah was present 13 days during the intervention and achieved level 9 (2643 trials). She was very quiet and did not express herself much or talk with other girls or the supervisors.

Initial literacy skills

According to Graphotable first session records Dinah recognized 14/24 phonemes (B, C, F, G, I, K, L, N, O, R, T, U, V, Y). Out of these there were two items (B, V) that were 100% in total playing time and 4 items with 95% or over total performance (see Appendix 4). Based on Overview, Dinah played V and B without any errors. The Levelscores shows us that the Level 6 (J H Y T D B V) was the easiest for Dinah and was passed with 3 playing times (Appendix 3).

Learning process

According to Graphotable records Dinah has not known A (44%), J (60%) or M (66%) at the first playing time. Also items E, P, W and Z have been played at 75% or below and D, H and S have been at 80%. These were the items Dinah needed training with. Overview graph shows that Dinah has struggled with Level 1 for three training days (14 playing sessions). Even though Dinah managed to get 100% (4/4) correct in the first playing session with target I, there has been obvious difficulties with it and it has not been learned during the intervention. Target A has been problematic as well although errors are not as common as with target I. Learning of A is somewhat uncertain as the mean line does not reach the top side of the graph. There has been a problem with target N as well but it has been learned during the second playing day. Target T was known very consistently in the beginning but there is a slight relapse with it in Level 2 when three new target items are introduced. In the following levels there were problems with K and J (not learned) and a long training time required to learn M, D, F, G, Y and W. There has also been uncertainty with target P which is barely on the better side of the graph and doesn't improve until Dinah learns target G in Level 5.

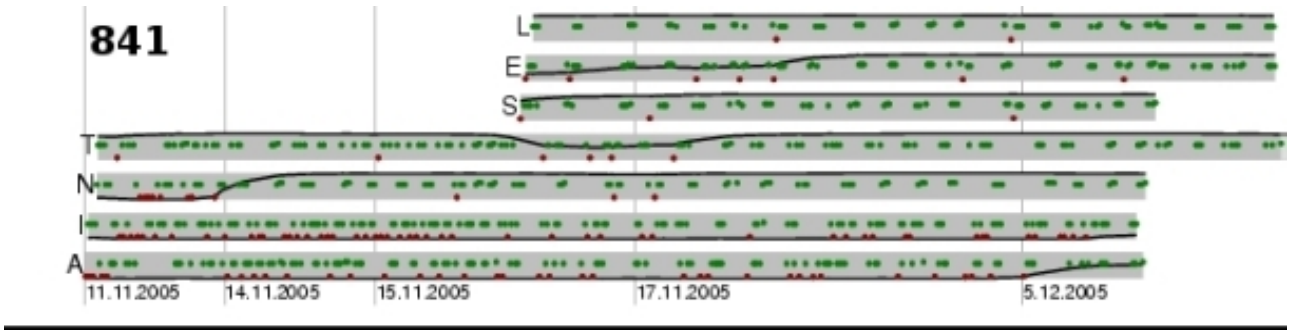


Illustration 4: Dinah 841 Overview detail showing performance in Level 1 and Level 2.

In Level 5 (P R D F G Y W) the only target that has been on top side throughout playing was R, all the others have been challenging. However, even though the Level 5 has been difficult (full 19 sessions before pass) the problems are more scattered than in the Levels 1 and 2.

Daisygraph gives a demonstration of this. The difficulties seen with target A and target I in Level 1 and 2 seem to be caused by reciprocal confusion of these two items. Target A has been played with distracter I for 119 times and Dinah's performance is still around 70%. Target I has been played with distracter I for 135 times and the development seems to go to the wrong direction.

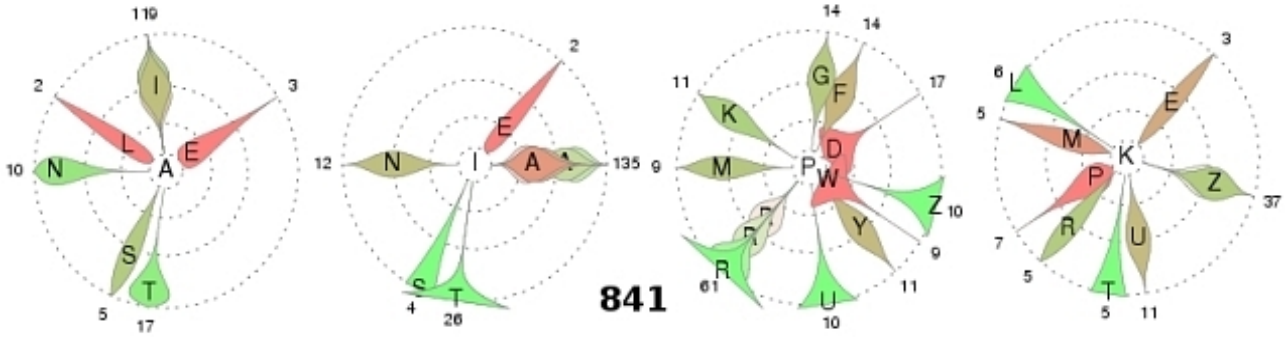


Illustration 5: Dinah 841 Daisygraph detail showing targets A, I, P and K.

For some reason, target P has been very difficult and it has not been learned to distinguish from D and W at all. Knowing the difference between target P and distracter R has started with somewhat same starting scores but with practice (61 trials), Dinah has finally reached 100% level. There have been quite few trials (9-17) with target P with most of the distracters, so more practice time could have improved her performance. Target K has been confused with Z but knowing the difference has been around 75%. Also, distracters P and U have caused some confusion with target K. The number of trials with target K is also small, so the difficulties with it are not comparable in severity with the ones with targets A and I.

Outcome

Dinah had great difficulties with learning A and I from apart. According to Graphotable first session scores, the problematic items were A, J, M, E, P, W, Z, D, H and S. According to Graphotable total playing scores, the most difficult items were I (129/178/72%), K (55/76/72%), P (116/158/73%), G (78/105/74%) and A (115/150/76%). According to Overview, targets I, J and H were not fully learned but J and H were played only for a little time. Also targets M and P did not reach top performance. Targets E, S, W, Z and D were learned firmly after initial difficulties. In December post-test Dinah wrote D, M and B right, and repeated her mistake with I. In January follow-up she wrote D right.

3.4 Ally 844

Ally was 8-year-old 2nd grade pupil whose mother tongue was Cinyanja. In July screening she knew A. She also wrote “moth” when item in the spelling test was AMAI (mother). In November pre-test she knew B, D and A. In both tests she wrote E when I was asked. Ally was present 11 days during the intervention, reached level 15 (3297 trials).

Initial literacy skills

According to Graphotable first playing session records Ally recognized 15/24 phonemes (B, C, D, F, G, J, K, L, M, O, S, U, V, Y, Z). Out of these there were five items (M, O, S, U, V) that were 100% in total playing time and five items that were 95% or better in total playing time (C, D, K, R, Z) (Appendix 4). Based on Overview, Ally played S, U, Z, O¸ M, C, D and V without any errors. The Levelscores shows us that Level 3 (T L E K U Z O) and Level 9 (TI ZI FI DO GO LO WO) were the easiest for Ally and she passed them on first playing time (Appendix 3).

Learning process

According to Graphotable first time playing records Ally has not known E (66%) and I (69%). Items H and T have been played below 75% and A, N, P, R, T, W have been played with 80% accuracy. Overview shows that even though Ally has been able to proceed in the game, targets A and I never reach the top performance until the 6th playing day when Ally has returned to play Level 1 either accidentally or for fun. The beginning of the game with targets I, E, T and L has been somewhat hard but Ally's general problems have been elsewhere. It has taken a relatively long time for Ally to learn target P accurately and similar up-and-down performance is seen with F, G, Y and W. According to Levelscores it took full 42 playing times during four playing days for Ally to pass Level 5 (P R D F G Y W). The second hardest level has been Level 2 that Ally played for 9 times to get it through.

The Daisygraph shows us that the mistakes Graphotable reported with target E were caused with mild confusion with distracters L (16 trials, above 75%) and A (6 trials, around 70%). Problems with target I were caused by confusion with distracter T (5 trials, around 60%). Target T has been mixed with distracter I and remained under 70% with 22 trials. Uncertainty with target A has been due to confusion

with distracters L and N, but these combinations have either 5 or fewer trials. Problems with target N are linked to confusion with distracter A (17 trials, around 70%). All in all, it seems that items in Level 2 have been confused with all the other distracters without any specific pattern.

On the contrary, target P has been seriously mixed with distracter R but with 122 trials the performance has reached around 90%. Target R has been mixed with distracters F and U to some extent and it has been played with distracter P for 144 times, reaching 100% performance. Target T has been mixed with distracter I and remained around 70% with 22 trials. The most striking pictures are from target items in Level 5 which show that target F has been confused with distracters P, R, Y and G, and target G with distracters R and F and also target Y with distracters F, R and W, which has remained around 70% percent.

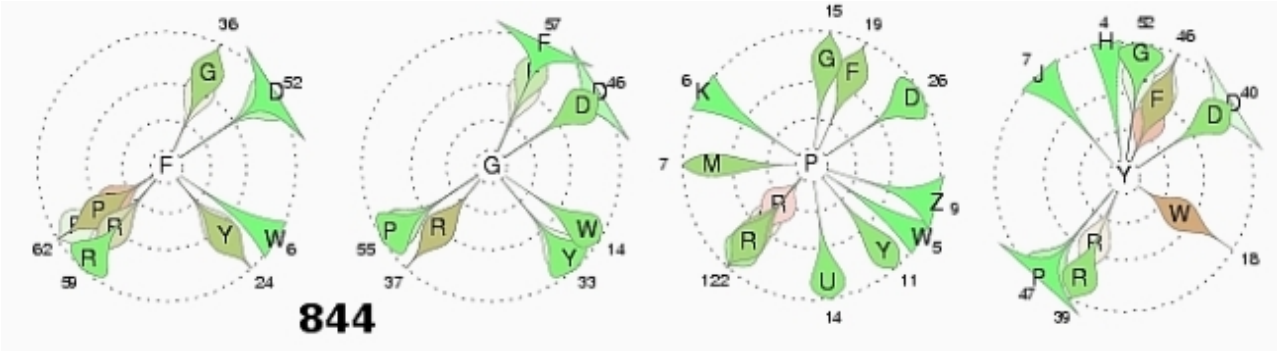


Illustration 6: Ally 844 Daisygraph detail with targets F, G, P and Y.

Outcome

In the first playing session Ally did not know E and I and also T and H were difficult. She learned E, I and T well enough to pass on to the next level, but the performance with them was not stable until Ally accidentally happened to try Level 1 again. Despite the initial difficulties target H total playing performance was 12/14/85%. Even though playing the Level 5 through took exceptionally long time for Ally, her performance with these items was relatively good all the time, e.g. in the total playing time the target D was 148/150/98% and the target R 168/176/95%. It was just the game's requirement of full 100% performance that kept Ally playing Level 5 for 42 times. Total playing time performance reports target F (81%) as the most difficult item. In December post-test she knew D, B, A, PA, UKA and AKO correctly. Yet, in January follow-up she knew only D, M and A correctly. Again, she wrote E when I was asked in both post-tests. Ally doubled her spelling score in the post-test. Unfortunately, the effect did not last till the follow-up test.

3.5 Lily 1538

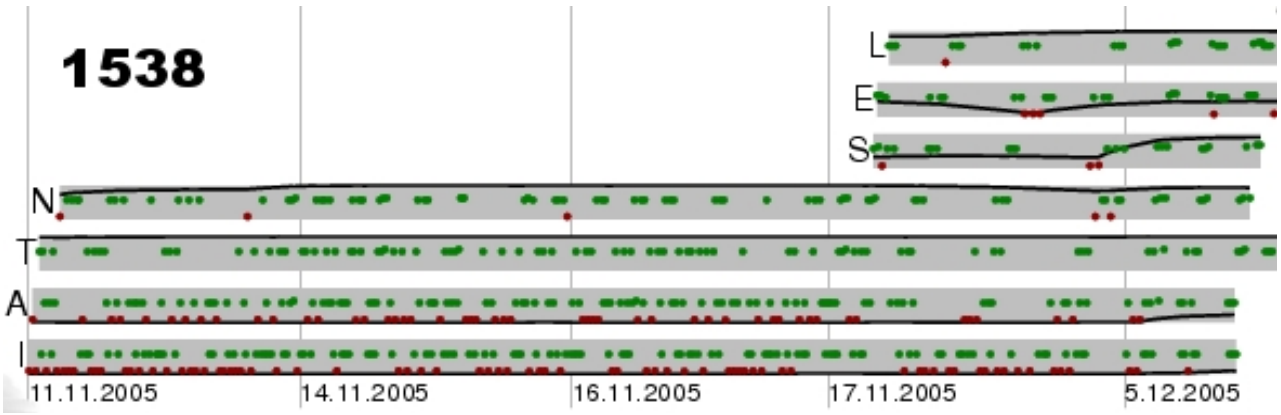
Lily was a 7-year-old 1st grade pupil whose mother tongue was Silozi. In July screening she did not get any of the items right, but in the pre-test in November she wrote B and I correctly. Lily was present in 11 days and played 107 minutes and reached Level 5 (1994 trials). At the time of the intervention we did not know that she was speaking Silozi. Despite the possibility that she probably did not understand all the instructions, she was able to proceed in the game although little slower than the others. She was also the youngest of the participants.

Initial literacy skills

Lily played five phoneme levels out of six (leaving out four phonemes B, H, J and V out of her playing). Therefore Graphotable says that Lily recognized 11/20 items (C, D, E, F, G, K, L, R, T, U, and Z). There were no items that would have had 100% performance in the total playing time, but the best ones were T (99%), Z (98%), M (97%), L (96%), G (96%) and R (95%). See Appendix 4. Based on Overview, Lily played target T without errors. The Levelscores show that Level 5 (P R D F G Y W) was the easiest for her and she passed it with 6 playing sessions (see Appendix 3).

Learning process

According to Graphotable, Lily has not know items I (38%), A (52%), N (69%) or P (66%) on the first playing time. Also items M, S, W and Y have been known at 80% performance level and O with 75%. Overview shows that Lily has struggled with target items I and A for five days and without really learning them. On the other hand, items T and N in the Level 1 have been played well. It took 17 playing times for Lily to pass Level 1. After that she managed to pass the Level 2 with only 7 playing times. There was also a long struggle with target K but it has eventually been learned. However, target O has not been learned at all and target C doesn't reach good performance levels either.



Daisygraph images explain these difficulties with targets A, I, N, O, C and P little better. When A has been the target and I the distracter, the performance was still around 75% despite of 130 trials. There has been some confusion with distracters N as well but also much less trials. The Daisygraph with target I look dramatic: there have been 156 trials with distracter A, and the performance has fluctuated between 50% to around 80% and ended with about 70% performance. It is also interesting that target I has been confused with distracter N and not been learned. Also, the three failed trials with distracter E indicate difficulties as well. On the other hand, even though target N was among the poorest items in Graphotable first playing time records, the Daisygraph of target N does not show any dramatic confusion.

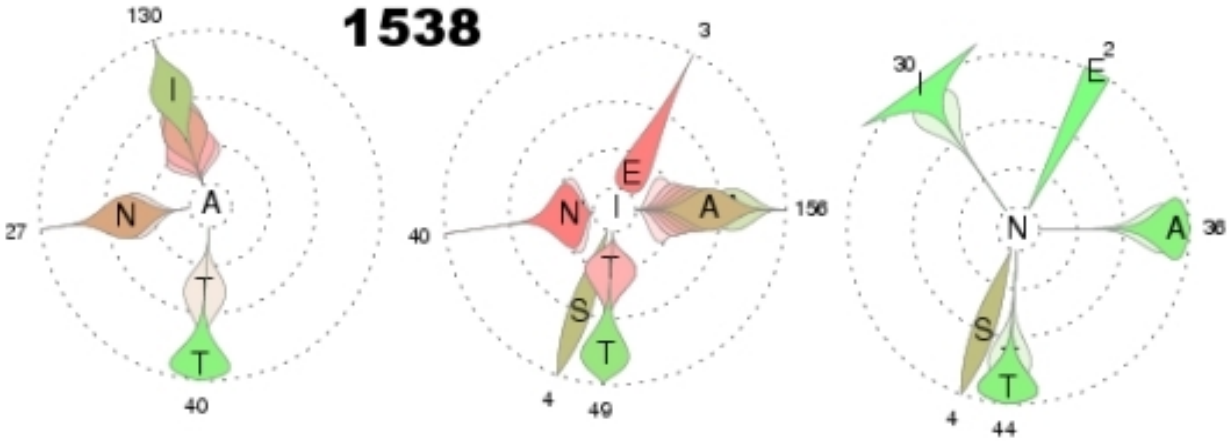


Illustration 8: Lily 1538 Daisygraph detail showing targets A, I and N.

With target P, it looks like some uncertainty with distracter C still remains but otherwise distracters have been learned apart from the target. With target C, there is still a problem with distracter K but there have been only 17 trials. And there have been problems with distracters K and U with target O,

but again, the amount of trials is much smaller than it was with target A and I.

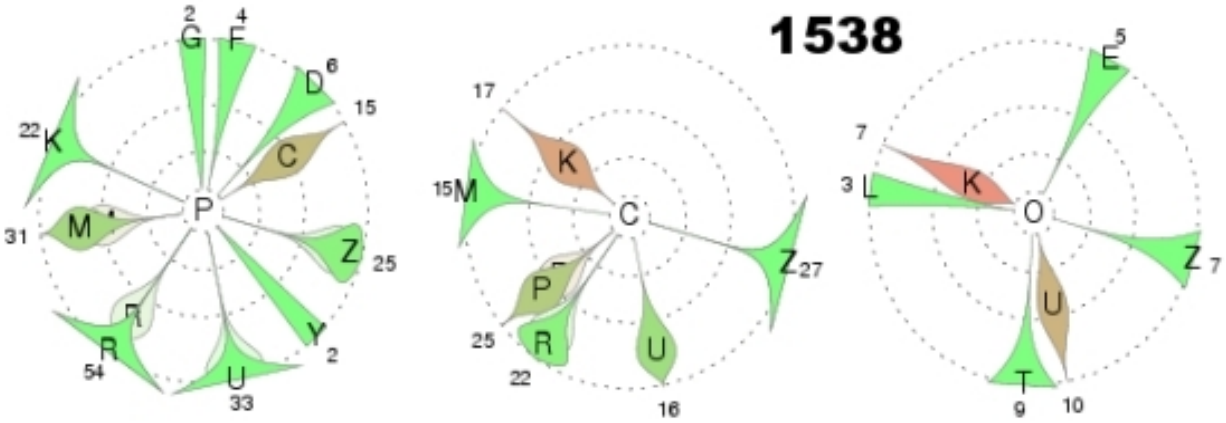


Illustration 9: Lily 1538 Daisygraph detail showing targets P, C and O.

Outcome

The difficulties Lily experienced with targets A and I are interesting. The raw data from gamelogs shows that when Lily has first started playing, the first six trials she got in the game had a choosing situation between A and I. This can be seen in Overview detail (Picture XX) where the time line for T and N starts little later than the ones for A and I. It is possible, that some initial misunderstanding has confused Lily and made it difficult to learn these two phonemes. However, even though Level 1 was difficult for her, playing Level 4 took just as long (14 times, see appendix 3). Also, Lily played other targets in Level 1 very well; in fact, target T was one of the best played targets in her game. There is also a question of language barrier and the possibility that Lily did not understand the game rules. Generally we did not let children start the intervention if it seemed that there was a problem with using the mouse or understanding the instructions. Lily was also the youngest of participants which might have affected her playing.

According to Graphotable total playing time records, the most difficult items in the game have been I (141/252/55%) and A (124/192/64%). All other items have been 82% or above in total playing time. The Overview shows that at the end of the time line the performance with target A has risen to the upper side of the graph while the time line of target I has remained at the bottom. Target M has also risen to the better side in the end. Targets N and S were learned fast and the performance was stable, but target P was fluctuating and ended barely to the better side of the graph. Performance with target O did not quite reach the top, while W and Y were learned after two days practice. Sadly, Lily was not present in December post-test but in the January follow-up she wrote correctly D and syllable NI.

3.6 Oprah 848

Oprah was 6-years-old 2nd grade pupil whose mother tongue is Cinyanja. In July screening she knew A and M and wrote E instead of I. In November pre-test she knew B, D, A and M but again, wrote E instead of I. She was present on 10 days, played 125 minutes, reached level 13 (2327).

Initial literacy skills

According to Graphotable first session records Oprah recognized 18/24 phonemes (A, D, E, F, G, I, J, K, L, N, O, S, T, U, V, W, Y, Z). Out of these there has been 10 targets (D, F, G, J, O, S, T, W, Y and Z) that have been played with 100% accuracy in total playing time and 6 items (I, K, N, P, R and U) that have been played with 95% or better (see Appendix 4). Based on Overview, Oprah played targets T, S, O, Z, D, F, G, Y, W and J without any errors. According to Levelscores, Oprah was able to pass Levels 1, 2, 3 and 5 on the first playing time (Appendix 3).

Learning process

According to Graphotable first playing time records, Oprah played targets B, C, H, P and R at 75% or higher accuracy in the first playing time and target M was played with 66%. Overview shows that even though Graphotable first time playing session record for Oprah with target M was poor, she rose to top performance very fast. According to Overview, B, C, P and R were learned very quickly and only the target H was not learned during the intervention. However, Oprah experienced some peculiar problems with Level 2. As mentioned above, Oprah was able to pass the Level 1 at once. She tripled her 100% performance with Level 1 and passed the Level 2 also on first attempt but, when she tried Level 2 again, it took her 14 playing times for her to pass it again.

Illustration 10: Oprah 848 Levelscores detail showing performance in Levels 1, 2 and 3.

The Overview shows what happened in the timeline in detail. Despite the fact that she passed the Level 1 on the first playing time, there were problems with target A. In Level 2 she had problems also with targets E and L. The target E takes the longest time for Oprah to learn. These three targets, A, E and L seem to have been the most difficult ones for Oprah.

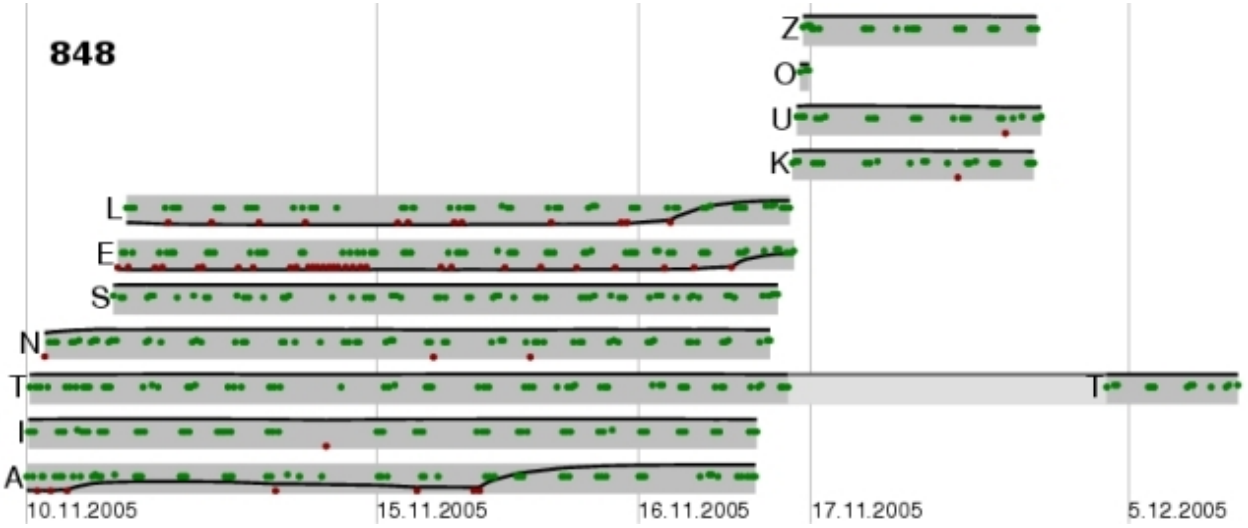


Illustration 11: Oprah 848 Overview detail showing Level 2 performance.

The Daisygraph gives more information on this. The problems seen with target A seem to have been caused by distracter I. There has initially been some confusion with these two but after 20 trials or so Oprah has learned the difference. The problem with target E is the distracter A which has been played 19 trials but which still is around 50% performance. There has been some problems with distracter L as well, but the performance has been around 70%. The target L has been mixed with distracters N and I, and the difference with these two has not been learned better than about 70% accuracy.

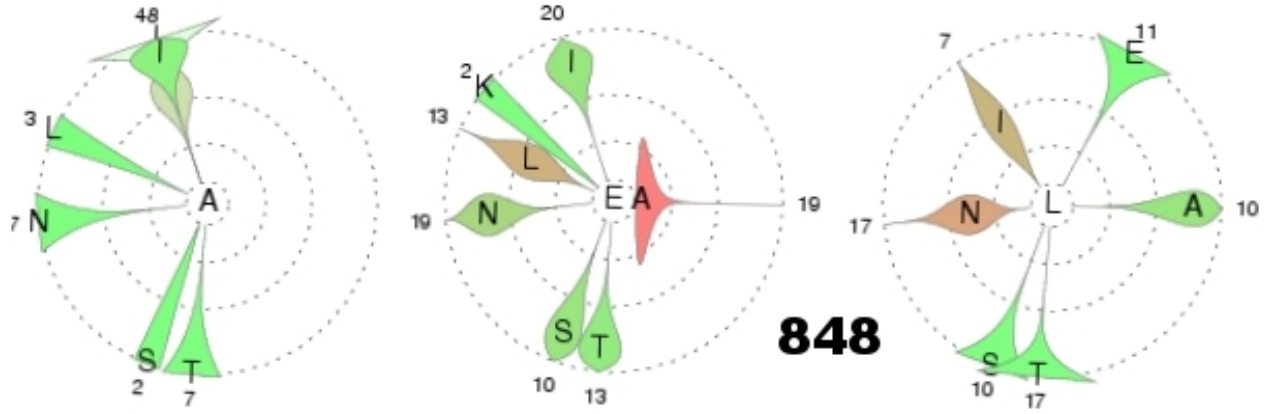


Illustration 12: Oprah 848 Daisygraph detail showing targets A, E and L.

Outcome

Oprah was a good player whose Overview graph shows almost vertical progress in the phoneme levels. Despite her otherwise good performance both in the tests and the game itself, Oprah had surprising difficulties with item E. In fact, she was able to pass the Level 2 on the first try just because she happened to get consonant distracters for target E at that time. When she tried the same level again, she got into trouble when vowels appeared together. In the total playing time score target E was played 60/69% and was the most difficult target for Oprah. Even though targets A and L seem to be difficult as well in the Overview, the Graphotable total playing score for A is 58/62/93% and for L 55/64/85%. The other low scores in the total playing time were B (15/17/88%), C (23/28/82%) and H (15/18/83%). Even though target P and R were difficult in the first playing time scores, the Overview shows that they were learned from one mistaken trial and the total playing score for P was 27/28/96% and for R 22/23/95%. All in all Oprah played well but she had persistent problem with vowel E. In both December post-test and January follow-up Oprah had B, D, M and A correct but again, wrote E when I was asked.

3.7 Wendy 843

Wendy was a 9-year old girl on 2nd grade whose mother tongue was Icibemba. In July screening she wrote A correctly and in November pre-test she wrote B and D correct. Wendy was present 9 days and achieved level 8 (1768 trials). According to observation notes, she had problems passing the first level and was confused with I and A.

Initial literacy skills

According to Graphotable first session playing records Wendy recognized 21/24 (B, C, D, F, G, H, I, J, K, L, M, N, O, P, R, S, T, U, V, Y, Z). Out of these, ten were played with 100% performance in total playing time score (see appendix 4). Based on Overview, Wendy played N, S, K, U, Z, M, P, R, F and G without any errors. The Levelscores show that Levels 3 and 4 were easiest for Wendy and she passed them both on first attempt.

Learning process

According to Graphotable Wendy had below 100% performance in first session playing records with three targets: W (75%), E (62%) and A (55%). According to Overview, there has been only one error with target W and Wendy has played it perfectly ever after. There have also been some problems with target D, but it has been learned relatively fast and Wendy has been able to pass the Level 5 on second attempt. However, the timelines for A and E look bad.

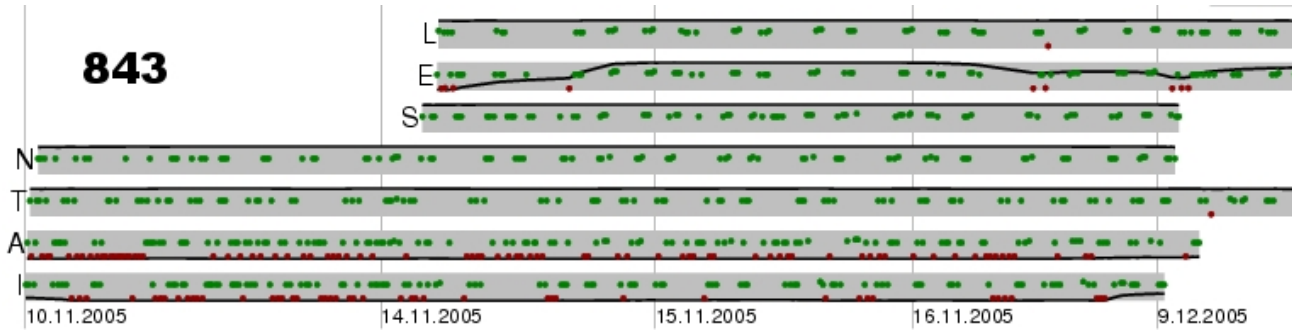


Illustration 13: Wendy 843 Overview detail showing Levels 1 and 2.

According to Levelscores it took nine times for Wendy to pass Level 1 and seventeen times to pass

Level 2. The Overview detail in the picture XX shows why: targets T, N and S (and L) have been played perfectly whereas targets A and I are showing a blank line throughout the game. There have also been some initial problems with target E but Wendy has learned the target within a day.

Daisygraph illustrates these three difficult items in detail. When A has been the target, it has been played with distracter I for 124 trials and still the performance stays around 60%. There has been some difficulty with other distracters too, but N and T have been learned well, and L and E have reached around 70% with very few trials. Target I has been played with distracter A for 128 trials and even though Wendy has almost got it correctly at some point, the final performance stays around 70%. On the contrary, the third difficult item, D, for Wendy has just some scattered errors with different distracters without any specific pattern.

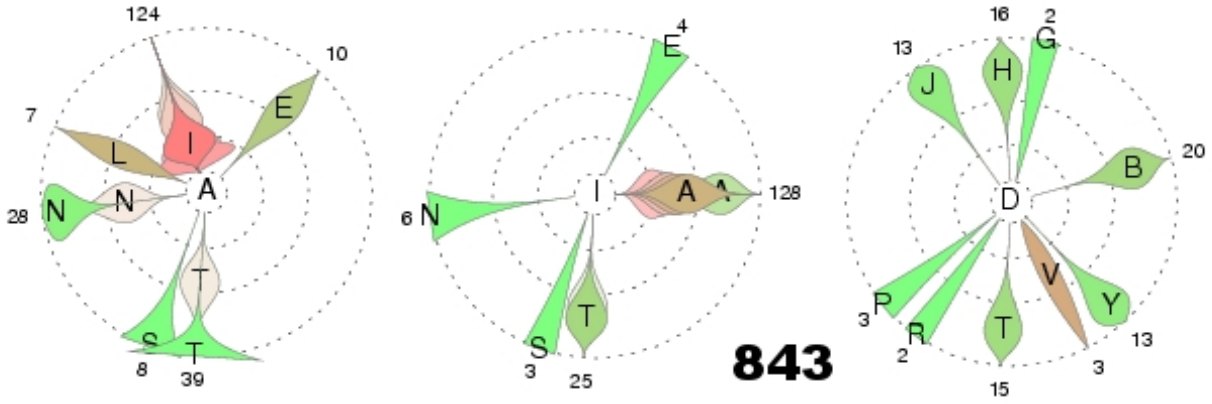


Illustration 14: Wendy 843 Daisygraph detail showing targets A, I and D.

Outcome

Wendy knew almost all the target items immediately when they first appeared in the game. Only A, I, and to lesser extent, W, caused any problems in the beginning. Overview shows that all items except A

and I were learned. Graphotable total playing score shows that target A was played at 118/200/59% and target I at 114/160/71% performance level. All other items were played better than 80% in the total playing time, for example, even though target E seemed difficult in the first playing session scores, the performance in the total playing score was 76/83/91%. In December post-test Wendy gained seven points writing correctly D, M, B, A, PA, MA and AKO. She wrote E, instead of I. In January follow-up she did not score at all.

3.8 Edna 831

Edna was an 8-year old girl 2nd grade whose mother tongue was Citonga. In July screening she wrote A and M correctly, and in November pre-test B, A and M. In both tests she wrote E when I was asked. Edna was the only player who had used a computer before. She progressed fast in the game and vocalized phoneme sounds. Edna was present on 12 days during the intervention and reached Level 25 (2781 trials).

Initial literacy skills

According to Graphotable first playing time records Edna recognized 21/24 phonemes. (A, B, C, D, F, G, H, I, J, K, L, M, N, O, P, R, S, T, V, W, Z). From these items, only F (92%), M (90%) and P (95%) were not 100% correct in the total playing time records (Appendix 4). Based on Overview Edna played most phonemes (I, A, T, N, S, L, K, O, Z, R, D, W, G, J, H, V, B) without any errors. The Levelscores shows us that Edna passed Levels 1, 4 and 6 on the first playing time (Appendix 3).

Learning process

Graphotable first time playing records show that Edna had some errors with E (71%), U (80%) and Y (75%). According to Overview, there has not been a visible problem with other items than target E. Target E is the only phoneme that has obvious problems at the beginning. Later when Edna was playing target E in Level 18, she did perfectly. The Daisygraph shows the problem behind the mistakes: target E was mixed with distracter A each time when this distracter was presented. Otherwise, Edna made only some occasional errors here and there, mostly because she could not always keep her concentration on the computer. Target E was the only phoneme where Edna had a specific problem.

Illustration 15: Edna 831 Daisygraph detail on target E.

Outcome

Edna was able to play the game to the 25th level. In fact, she made it to the syllable levels on her second intervention day. In the Graphotable total playing scores the poorest items have been E (27/30/90%), F (13/14/92%), M (10/27/90%), U (26/28/92%) and Y (15/16/93%). Others were played 95% or better even in the total playing scores.

In her overall playing, the most difficult level was Level 12 which had items like NZU, NJU, KHA and KA. When Edna was playing the word levels in the game, she told spontaneously that she uses the first sound of the word as a cue to choose the item. She was able to read words like PHALA and CIMANGA from the screen if she split the word into syllables when reading. In December post-test she wrote D, A, TA, PA and MA correctly. In January follow-up she wrote D, M, B and A. In both of these tests she wrote E instead of I.

3.9 Summary of the results

3.9.1 General observations

Case stories of these eight children include several positive experiences of the game. First of all, all the children were able to progress in the game despite their language differences and novelty of the teaching method. Second, several children (Edna, Wendy, Oprah and Ally) showed clear improvement in the post-tests right after the intervention session, which means that they were also able to transfer their new knowledge to a different type of literacy task[8]. However, the improvement children showed in the post-test did not last to the follow-up. Also, the intervention was not sufficient enough to correct some of the most persistent spelling errors (writing E instead of I when hearing sound /i/). This is not surprising though, as 2 hours of playing is usually the minimum time for Literate game intervention and it was originally planned for children to have reach 4 hours playing time. The mean playing time in this group was just 145 minutes.

As this was the pilot for Literate game interventions in Zambia, there were several surprising issues in the game outcomes. The original idea behind this study was the similarity between Finnish and Zambian languages. It was assumed that as the pronunciation and orthography is very similar, it would be relatively easy to make Cinyanja translation of the game. The game translation was made in line with Basic School Framework 2000 and the NBTL policy, assuming that first grade pupils really learn only Zambian Native Language, which would then logically mean that in the second grade pupils' knowledge of ZNL should be rather good.

The Appendix 3 shows that the Level 2 was surprisingly the most difficult phoneme level for this group. It was the only level that contained vowel A, I and E in the same set. Case stories show that the problems with these three items were persistent and dramatic in comparison to other items. Even some of the best players (Edna and Mary) had difficulties with some of these three items while all other phonemes were easy. Also, Appendix 4 shows that there was clear distinction between the easy and

8 Biggest improvement was Wendy's: from 2 points to 7 points, Edna improved from 3 to 5 points, Oprah from 2 to 4 points and Ally from 3 to 6 points. Dinah got 3 points from both pre- and post-test and Lily did not participate in post-test. Rudy went backward from 3 points to 2 and Mary from 5 pre-test points to 1 in the post-test.

difficult items. Only one child (Edna) played target A at 100% level throughout the game. Only one child (Mary) played the target E at 100% level throughout the game. Three children, Mary and Edna, played target I at 100% and Oprah at 95% or better in the total playing score. This also indicates that these three items were particularly difficult. It is also worthwhile to mention that only one child (Oprah) played target Y at the top level (discussed later).

On the contrary, target R was played 95% or better by 7 players, and 6 players did just as well with target S, and 5 players made similar performance with T, Z and K. It is surprising that even though the consonant phonemes are often said to be difficult to pronounce (Lerkkanen, 2006) and difficult to understand at first hearing, the majority of these children played these five items almost perfectly. The difficulties in vowels seem illogical and surprising, and were not expected to happen when the game translation was designed.

3.9.2 Performance pattern

One possible explanation for this phenomenon was that the novelty of the computer and game playing was causing the problems in the Level 1, making children learn items A and I in a wrong way. This is improbable because all children tried the game before starting their intervention and it was made sure that the children understood the rules of the game. This misunderstanding explanation was considered to explain Lily's performance as it was found out only after the intervention that she was actually Silozi speaker and the instructions were given mostly in Cinyanja, Icibemba and English, depending on which of the assistants happened to be available. Yet even Lily was able to progress in the game and she made mistakes in the Level 1 only with A and I, and not with T and N. Also, if the game itself was causing the problems, why it was the Level 2 which turned out to be the difficult one instead of Level 1?

The hints for the explanation came along the research process. First of all, almost all the children made a consistent error in the Spelling test, writing letter E when they should have written letter I. They also used letter E in words in which I would have been the right form (IMA, not EMA). Some children also wrote, or tried to write full English words in the Spelling test, even though it was clearly said that they are supposed to write in Cinyanja. For some reason, the children were thinking in English, when they should have been thinking in Cinyanja or in other ZNL. Most of the children in this group were in Grade 2, going to start Grade 3 and according to the Basic School Framework they should have been

fluent in ZNL and only starting to learn English literacy skills. In any case, these observations suggested that children were confusing English and ZNL with one another.

Table 3: Comparison of English letter names and Zambian Native Language phonemes

Letter	***English letter name***	***English letter name pronunciation***	***ZNL phoneme***
A	"AY"	[ei]	/a/
E	"EE"	[i:]	/e/
I	"EYE"	[ai]	/i/

If we look at the pronunciations of letter names in English and phonemes in Cinyanja, (see Appendix 5 for more) we can see an interesting pattern. In the Literate game, the players are supposed to make a fast choice based on the sound they hear from the headphones. The player has 2-6 items on the screen and has to pick up the one he or she thinks best matches with the sound. When children have learned a phoneme sound, the right choice of a corresponding letter is known instantly after hearing the sound. The letter-sound correspondences should be automatic knowledge. If we look at the case stories, which combinations seem to be automatic for these children? For example, when Oprah has played target E, she has chosen distracter A each and every time (19 trials) when these two have been on the screen. This indicates that she has been convinced that choosing A when hearing /e/ is the right way to play. Rudy has been almost as consistent as Oprah; she has played 29 trials with target E and distracter A, and showed only small progress in correction of this misunderstanding. Even Edna, the best player in the group, chose distracter A instead of the correct target E. Similar behavior is seen between items A and I. This is strange behavior from children who, according to the curriculum, should have learned vowel sounds of Zambian Native Languages already in the beginning of the first grade.

3.9.3 Explaining the pattern

Let's change the perspective and imagine that, for some reason, we have learned the alphabet names in English instead of the alphabets or phonemes of Zambian languages. How would one act when playing the Cinyanja game? The player hears /a/ from the headphones, which also happens to be the beginning sound of letter name EYE. If you're asked to make a fast choice, would you rather choose an item that resembles [ai] which you have learned by heart, or would you rather choose an item that you have learned to be AY, pronounced [ei]? Or in a similar choosing situation, you hear sound /e/ and see two options on the screen, A and E. Would you rather choose the one that you have learned to be pronounced [ei] or would you choose the item that you have learned to be pronounced [i:]?

There were several children who seemed to think that they should choose distracter I when playing target A (Mary, Dinah, Oprah, Rudy, Wendy and Lily). Also there were some cases (Mary and Dinah), when distracter E was chosen when A was the target. When I was the target and A the distracter, Dinah, Rudy, Wendy and Lily preferred choosing the distracter. And again, when the target was E and distracter was A, Oprah, Rudy and Edna thought they should choose the distracter.

These choices were very persistent despite the fact that the game told each time if the player's choice was right or wrong, and showed the correct item right away. There were cases where even 156 repetitions of this feedback was not enough to make the child believe that she was making a mistake when choosing the distracter. In some cases (e.g. Edna) the children were able to progress despite their problem because the target item, such as A, was presented so many times with other distracters of the level (like S, N and T) that they were able to collect three subsequent correct answers and get a score from the target. This was also the reason why Oprah was able to pass the Level 2 on first attempt as she happened to get easy consonant distracters for the difficult vowel targets and her vowel confusion did not affect the playing score. However, she was in great trouble when vowels started to appear together.

So, sticking to the theory that the children have learned the English alphabet names instead of Zambian Native Language, we can also understand why the consonants were so easy. There are no major differences in most of the consonants. However, in ZNL system G is /g/ (like in English word “gorilla”) instead of English letter name GEE [d3i:]. Letter H is /h/ instead of English AITCH [eɪtʃ] and letter Y

is /j/ instead of English WYE [wai]. The Appendix 4 shows that these letters were not played very well: four children played G at top level, three played H and one played Y. Also target W was played well only by two children (Oprah and Edna). The letter name DOUBLE-U [dʌb.l̩.ju] is very different from Zambian pronunciation which is little bit like /wh/ in English "what" (but cannot be confirmed here as there was no IPA coding for ZNL available). On the other hand, all items which were similar or identical with English were played well by approximately half of the children. It is also possible that the differences in children's home language can explain some difficulties with consonants as there are variations in the pronunciation, for example letters R, V and Z do not exist in Icibemba (Hoch, 1960).

Based on this evidence it can be argued that these eight children were suffering from literacy problems and thus remained in the poorest reader group of their grade level because they had originally learned the English alphabet instead of the Zambian Native Language alphabet. Sadly, they had also learned the English version so well that this short intervention period was not enough to correct this error, which resulted in confusion with the vowel sounds in Cinyanja. This can be seen also from the children's Spelling test answers as they were using English-based logic in spelling of Cinyanja words which of course, resulted in wrong answers. Also, like Mary's case accidentally revealed, these children were trying to use the English alphabet system in forming of Cinyanja syllables which is, of course, very difficult because it is impossible to get syllable RU (/r/ and /u/) when putting together English [a:] and [ju:]. It is likely that these children will continue to use English pronunciation and letter names when spelling Cinyanja, which will risk their performance in the national exams. Failing the exams can result in dropping out of the education system, which might have a serious effect in the lives of these eight girls.

4. Discussion

The objective of this study was to explore the possibility of transferring a Finnish literacy teaching method to Zambia. This idea was based on the apparent similarity of Finnish language and Zambian Native Languages. It was also hoped that the study would bring new information about the underlying reasons for the low literacy levels in Zambia.

4.1 Benefits and setbacks of the Sewero-la-ma-u pilot

The first research question was simply: is the Literate game beneficial to Zambian children? The answer is yes. Children were interested in the game and motivated to play, they were able to progress in the game and half of them showed improved performance in the post-testing. All this even though most of them had never used a computer before and many of them did not speak Cinyanja as mother tongue. However, there were some deficits in the game itself which must be corrected before the game is used further. The most serious of them is that Cinyanja phoneme /ŋ/ was not used at all. Second, the order of the game items seemed to be problematic. The items which were considered to be easy, turned out to be difficult, which is against the ideology of the Literate game: the game is supposed to be adaptable so that each player will have training in his or her own individual learning rate where the number of correct choices is relatively high (Lyytinen et al. 2007). Third, there seemed to be a technical problem with random presentation of the distracters. Only one child (Lily) had trials with target I and distracter E combination in the game and yet that was the phonemic confusion children expressed in their spelling test answers.

It is also true that the effects of the intervention did not last to the follow-up testing. This is most probably explained by the intervention procedure itself. In the Literate game studies the usual procedure has been that children have played 10-20 minute sessions a few times a week, played not less than 60 minutes and players have been instructed to pronounce the target words aloud after hearing them (Lyytinen et al, 2007). In this study the intervention was much more irregular, as the children simply did not come to school each day, for example, due to heavy rain in the mornings. Moreover, despite encouragement and demonstrations, only two children (Mary and Edna) pronounced the sounds aloud while playing, others were simply too shy to do that or forgot to do so after some trials. This

issue about pronunciation is important as it helps the child to remember the letter-phoneme connections better, which is why pronunciation of phonemes is also an element of classroom teaching methods in Finland (Lerkkanen, 2006; Sarmavuori, 2003). Also, from the teacher's point of view, it is difficult to know if the child has understood the phoneme correctly unless the child vocalizes it him or herself.

Of course, always, when a study has been done with a small group, the generalisation of the results needs consideration. In this study there was only eight pupils, all girls, and the group varied in age, grade level and language. The variety of age is a common real life problem in African schools. First of all, children might not even know their own ages (Alcock & Ngorosho, 2003) and the age when children start school varies greatly. Therefore children of same age can have different amount of school years or children at same grade can vary in age. It is also very common that there are children from various language backgrounds in a class (Muhau, 2005). In this study, four out of seven largest language groups were presented but the language seemed to relate only to the performance of the Silozi speaker. However, it is quite likely that this child is experiencing similar problems in a classroom, which might explain why Lily was having problems in literacy in the first place. Thus, if the criterion for valid sampling is presenting unbiased reality, it is worth understanding that in Zambia, heterogeneity is the reality.

4.2 What hinders Zambian children from learning?

The second research question was to find out the possible explanations for low literacy performance in Zambia. It is true that literacy levels have greatly improved after starting the PRP/NBTL programme (Kelly, 2000) but the pupils' performance is still at very low level (Matafwali, 2005; Kalindi, 2005) and the standards given by the Ministry of Education in the Basic School Curriculum Framework (2000) have not been reached. However, learning to read in a regular orthography with one-to-one phoneme-grapheme should be rather easy, especially compared to English (Wimmer & Aro, 2003; Seymour et al, 2003; Thorstad, 1991; Öney& Goldman, 1984; Goswami, Porpodas & Wheelwright, 1997; Spencer & Hanley, 2003; Geva & Siegel, 2000; Aro, 2005).

So, what hinders Zambian children from learning? The answer is rather complicated. It relates to the full history of education and language policy in Zambia (and Africa in general). English is a highly valued language in Africa and many people prefer it to the native languages (Webb & Kembo-Sure, 2006a). Admiration of English language has lead to inadequate school instruction and shocking results from literacy research. For example, in South Africa it has been found out that only about 25% of the

adult black population is actually functionally literate in English[9], and that only 5% of the teacher trainees in the same population have adequate skills in English, yet, they're supposed to teach in that language at schools (Webb & Kembo-Sure, 2006a). Sociolinguists in South Africa, Nigeria, Cameroon and Kenya have concluded that the decision to use English as the language of learning, especially in primary schools, has definitely contributed to the underdevelopment of those countries (Webb & Kembo-Sure, 2006a).

Now, after 40 years of dominance of English language in Zambia, the language policy has changed, but has the policy really changed school practises? In order to give adequate instruction in Zambian Native Languages, teachers need to have profound knowledge of the language, its linguistics, pronunciation and standardised spelling. If the teachers themselves have been schooled in the English era, how could they have information of such issues without retraining? Also, the current system still faces the mother-tongue problem in a country of dozens of languages. It has been found out that it is not harmful for the teacher to speak a different ZNL than his or her pupils (Linehan 2004), but that pupils, who are non-native speakers of the ZNL used in their school, have lower ZNL literacy skills on Grade 3, although they catch up their peers on Grade 5 (Muhau, 2005). Thus, even the differences within ZNL's can be risk factors for the pupils' education.

But, as this study has illustrated, it is even more harmful if the pupils are not taught about the differences between alphabet codes in Zambian Native Languages and in English. When a phoneme-grapheme connection has been learned well enough to be automatic, it is very difficult to reverse the learning process and teach something else. Many of the children in this study demonstrated this, giving persistently wrong answers with certain vowels. Moreover, these wrong answers seemed to derive from English alphabet names. It is a common practise in Zambia to teach the “Alphabet Song” and other rimes to children without realising that it will make the children learn the letter names in a wrong language. Once learned, it is difficult to correct the misunderstandings, which will lead repetitive errors in literacy tasks and possible failure in the ZNL examinations.

And to be specific, whatever the language is, using the letter names might not be beneficial. For example, in Finland, letter names are no longer used in literacy teaching because they are confusing to the children (Lerkkanen, 2006). If the issue with letter names has been found to be problematic within one language, it is obvious that problems included are more severe when letter names are taught in a different language. Therefore it is crucial for teachers to be aware of this issue: the difference between

9 English is adequately known by 26% of Zambian people (Webb & Kembo-Sure, 2006a)

a letter name and a phoneme must be clarified to the pupil (for example, in Finnish, “a letter whose symbol is M is called ÄM and its sound is /m/”) and it is very important to be precise about when to talk about letter name and when about phoneme (Lerkkanen, 2006). Some say that children should be taught only the sounds and the symbols that clearly constitute the alphabet code (McGuinness, 2004) and leave out the letter names completely. Thus, it could be reasonable to prefer similar teaching in Zambia too and inform not only the grade school teachers, but nursery and pre-school teachers and parents about this issue as well.

The literacy problems in Zambia relate also to the paradigms and policies in the scientific research of literacy teaching and learning to read. As it has been previously mentioned, English language has dominated the field of literacy research for many decades and most of the well known models of reading acquisition are based on English data (Aro, 2005; Öney & Durgunoglu, 1997). However, there may be differences in the rate and developmental trajectory of learning to spell and differences in the types of errors found, depending not only on orthography but also on the phonological patterns that are legal in a language (Alcock & Ngorosho, 2003). Therefore literacy teaching methods should be adjusted to each language or at least, each alphabetic coding system (McGuinness, 2004), and models for these methods should be searched from education systems in countries that have similar linguistic characteristics. Simply saying, English does not function as an all-around model for literacy instruction and it is unwise to design curricula based solely on ideas from research on literacy acquisition in English language.

In the case of Zambia, the effect of English goes further than just teachers teaching the wrong alphabet. The new NBTL system has many characteristics of whole-word method and seems to lack a stage where letter-sound correspondences would be systematically taught. The NBTL seems to be an analytic method, which starts from big items and goes down to small items, starting from a sentence and breaking it to words, syllables and finally phonemes. There might be reasons to do this, such as promoting children's interest in written material as such but there are certain side-effects. In Finnish language the use of analytic methods has been problematic because the letter-phoneme correspondence remains easily misunderstood (Lerkkanen, 2006). Also, the central features of Finnish language such as length of sounds, morphemes and understanding syllable limits has been difficult to learn, which has resulted in reading errors even after long practise. The whole-word method has been criticized as it

urges children to guess words and ignore the real meanings which might be situated in a morpheme in the end of the word (Lerkkanen, 2006). If linguistic similarities between Finnish and Zambian Native Language are considered, the problems seen in Finnish schools are probably seen in Zambian schools as well. Also, there is evidence that the systematic method works also in African languages. As mentioned previously, the Finnish children usually get the idea of reading right away when they have learned the phoneme-grapheme correspondences. The same has been found out to happen in Tanzania in Kiswahili language: after learning the code, Tanzanian children are able to decode all the words, even those they don't comprehend (Alcock & Ngorosho, 2003). Moreover, there is evidence that whole-word method should not be used even in English (McGuinness, 2004).

4.3 Summary

If we seek the answer for the current literacy situation in Zambia, there are many explanatory factors. First of all, the curriculum presents theories and methods, which are made for entirely different alphabet code and cannot be transferred to Zambian Native Languages as such. Moreover, these theories and methods are outdated even for English literacy teaching (McGuinness, 2004) and they are not used in other countries with regular orthography and transparent phoneme-grapheme correspondence, like in Finland (Lerkkanen, 2006; Sarmavuori, 2003). Teaching children letter names in English, when phonemes of the Zambian Native Languages should be taught, is culmination of the history of education policy in Zambia and also, culmination of scientific debate in the literacy research. Yet, this might be the turn of the tide. The interest in the literacy skills in Zambian Native Languages has awakened at the same time with increasing interest in studying literacy acquisition in non-English languages very similar to ZNLs. There's a growing body of research which provides theoretical support and ideas for developing teaching methods also in Zambia.

It would be important to promote linguistic research on Zambian Native Languages. It seems that in many ways, the ZNLs have not been adequately studied and the dictionaries and pronunciation instructions available are few and contradictory to each other, in other words, the standardization process seems to be incomplete. The first step to teach literacy is to understand the complete structure of the writing system (McGuinness, 2004). Teachers should be educated about linguistics so that they could have a firm understanding of the languages they're teaching; otherwise it is difficult to teach things such as pronunciation, phonemes and spelling to the children. This information is needed just as much when the teacher is working in his or her mother tongue, as it provides possibility to recognise

special problems that children can have e.g. spelling mistakes that are related to the home language of the child or, like in this study, exposure to English pronunciations.

Making these changes happen in a developing country, will of course, require financial help. For many decades millions of dollars has been used to promote education in Africa: schools have been built, books have been donated and teachers have been trained, but what has been the use if the most crucial problem is in the theoretical knowledge of literacy teaching? Even if the teacher has all the hi-tech equipment in the classroom, all the teaching will come to nothing if the wrong methods, based on wrong background theories, are being used. On the contrary, if the teacher has the correct methods, it does not matter if teaching takes place in a modern classroom or under a tree: teacher will know the subject, know how to explain it and be able to improvise and create own teaching materials if needed. The essence of providing adequate literacy teaching to the children is understanding the subject itself. If you don't understand the subject, you end up teaching your own misconceptions to the pupils and all the effort of teaching in the first place, is wasted. Therefore, if improving literacy levels in developing countries is a public concern, the target of financial and professional help for countries like Zambia, should be developing adequate teaching methods based on scientific research on reading and linguistics in local languages.

Acknowledgements

Most of all, I want to thank my team mates Sylvia Kalindi, Beatrice Matafwali, James Chilufya, Simon Kaoma, Rodrick Mando and Grace Kachenga for all that we've done together during this journey. I also want to thank Principal Robam Mwaba of Zambia Institute of Special Education for encouragement, permanent secretary Lilien Kapulu and the Ministry of Education of Zambia for giving us the chance to conduct our research. Thanks to R.E. Banda from the Curriculum Development Centre. Many thanks to Ulla Richardson, Jane Erskine, Anne Alanko, Tuomo Hokkanen, Janne Kujala, Kimmo Teerimäki and all others in the Graphogame project. Thanks to Lotta Heiskanen for the support during my stay in Zambia and to Elina Seppä for help with the gamelogs. Thanks to Jari Westerholm for helping with the statistics. Thanks to the Niilo Mäki Institute for this extraordinary possibility. I also want to express my gratitude to Mama Mäki who got me into this in the first place and to Professor Heikki Lyytinen for his patience and support during the process.

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Appendix 1: Spelling test

Spelling test was administered four times during the study (July, November, December 2005 and January 2006). Children were instructed to write in Cinyanja and instruction was provided in Cinyanja and English. Spelling test was administered by native speakers of the language, a teacher or a research assistant. Each correct answer was given one point.

In the screening test the mean of Grade 1 pupils (N = 75) was 2.96 points with Std. deviation 2.3 and range of 0-9 points. The participants of this study were selected from the pupils with 0-1 points. Only one pupil (Lily) made it to the final group. The mean of Grade 2 pupils (N = 65) was 3.78 points with Std. deviation 3,18 and range of 0-13 points. The participants of this study were selected from the pupils with 0-2 points. The screening was done in the middle of the school year.

Screening and pre-test	**Post-test and follow-up**
B	**D**
D	**M**
A	**I**
I	**B**
M	**A**
be	**ta**
ni	**ni**
ma	**pa**
ta	**be**
pa	**ma**
ona	**uka**
ako	**ima**
ima	**ona**
uka	**ako**
eka	**eka**
koma	**imba**
mseu	**amai**
imba	**koma**
taya	**taya**
amai	**mseu**

Appendix 2: Sewero La-ma-u game contents

Level 1: **A I T N**
Level 2: **A I T N S E L**
Level 3: **T L E K U Z O**
Level 4: **K Z U M P R C**
Level 5: **P R D F G Y W**
Level 6: **J H Y T D B V**

Level 7: **SU RU MU CU NU PU KU**
Level 8: **NU PU KU MI TI ZI FI**
Level 9: **TI ZI FI DO GO LO WO**
Level 10: **DO GO LO WO BE VE YE**

Level 11: **NE NYE NDE NGE NZU NJU NKHU**
Level 12: **NZU NJU NKHU KA KHA KWA GWA**
Level 13: **KHA KWA GWA BWA MWA DWA MPHA**
Level 14: **PHI PHA PHE PHO PHU MPHU**
Level 15: **PHI PHA THU THE KHO KHE NKHA**

Level 16: **ZI DZI NZI BZI CI TSI SI**
Level 17: **DI DZI BE BWE NO NGO**
Level 18: **GE GWE E MA MBA A PU PHU U**

Level 19: **U-ZA U-MA U-SA U-CI U-FA U-VE U-WA**
uza [tell/inform], uma [to dry up], usa [to rest], uci [honey], ufa [mealie meal], uve [dirty], uwa [barking]

Level 20: **U-CI U-FA U-ZA A-NA O-NA I-NE I-WE**
ana [children], ona [to see], ine [me], iwe [you]

Level 21: **DU-WA CA-LA FU-NA CI-SA TA-TE BU-KU GA-LU**
duwa [flower], cala [finger], funa [to look for], cisa [honeycomb], tate [father], buku [book] galu [dog]

Level 22: **MA-DZI DZI-NA MUD-ZI PHA-LA KHA-LA BZA-LA MA-NJA**
madzi [water] dzina [name] mudzi [village] phala [porridge] khala [to sit] bzala [plant] manja [hands]

Level 23: **GA-MI-ZA MI-SI-KA SE-WE-RA MA-KO-LO FU-PI-KA KA-VA-LO**
gamiza [think] misika [markets] sewera [play] makolo [parents] fupika [short] kavalo [horse]

Level 24: **KU-MBU-KA MA-SA-MBA CI-MA-NGA PHU-NZI-RA NYE-NYE-ZI ZI-THU-NZI**
kumbuka [to remember] masamba [leaves] cimanga [maize] phunzira [learn] nyenyezi [star] zithunzi [pictures]

Level 25: **CAKA CALA | DZIRA DZIWA | MVEKA MVERA | BWALO BWATO |**

Appendix 3: Levelscores summary

This is a table showing how many playing sessions it took for the children to pass a level with 100% score. The largest number in each column is bolded. The last digits in brackets on each column show how close to 100% a child got before intervention stopped. For example, Rudy has played Level 13 for eight times and her last score in that level was 90%.

When counting together all levels with more than one player, the mean number for sessions is seven. For phoneme levels only, the mean number is six. When looking at the whole game, it is logical that the most difficult one was Level 7 which was the first level with syllables. However, if we look at the phoneme levels only, there are interesting details. First, if Oprah's case is considered, it is known that she passed Level 2 on first attempt. However, when she tried it again, it took 15 sessions for her to reach 100% performance due to different presentation of distracters. Thus the more realistic mean number for Level 2 is 11.9. Also, we know that Ally had difficulties with Level 5 and required 42 sessions to get 100% score. If this result is ignored, the mean session for Level 5 is only five.

The case stories show that while problems in Level 2 were mostly caused by errors in three particular items, the errors in Level 5 were more scattered. The game was also supposed to increase in difficulty so it was expected that Level 5 would be more difficult than previous levels. Nonetheless, no matter if we included Ally and Oprah or not, the Level 2 (A I T N S E L) has been the most difficult phoneme level for these children. Also, Level 5 contains ambiguous (from the Cinyanja-English point of view) phonemes (P R D F G Y W) as well.

This table is not, as such, a statistical evidence of anything; it is more like an illustration of the overall playing process in one picture, showing great variation in performance and experiences during the intervention. See Appendix 2 for game level contents and Appendix 5 for alphabet code comparisons.

Level	*Rudy*	*Wendy*	*Mary*	*Edna*	*Dinah*	*Ally*	*Lily*	*Oprah*	*Mean*
1	2	9	6	1	14	2	**17**	1	6,5
2	**26**	**17**	1	3	17	9	7	1 (**15**)	10,1 (11,9)
3	1	1	2	2	4	1	8	1	2,5
4	3	1	7	1	10	2	**17**	5	5,8
5	2	2	1	4	19	**42**	6	1	9,6 (5)
6	1	10	1	1	3	4		4	3,4
7	20	14	9	7	**21**	6		11	**12,6**
8	1	(1/95%)	3	1	2	1		2	1,7
9	**7**		3	4	(2/95%)	4		5	4,6
10	16		6	2		1		8	6,6
11	25		14	4		6		10	11,8
12	4		**25**	**15**		9		12	13
13	(8/90%)		5	3		8		(6/ 95%)	5,3
14			(2/65%)	3		5			4
15				6		(6/85%)			
16				2					
17				5					
18				2					
19				1					
20				2					
21				1					
22				2					
23				1					
24				1					
The mean playing times required to pass a level including 14 Levels (Phoneme Levels)									**7 (6)**

Appendix 4: Easy targets with presented distracters

Item	*Rudy 791*	*Mary 789*	*Dinah 841*	*Ally 844*	*Lily 1538*	*Oprah 848*	*Wendy 843*	*Edna 844*	Cum.
A								I E	**1**
B	J H Y V	J H D Y V T	J H D Y T					H Y	**4**
C		*K M P Z R U*	*K Z U R P M*	*K M P R U Z*			K M P R U Z		**4**
D		J H F B Y V T R P		*J H G F W Y V T R P*		J H B Y T P		H Y T R P	**4**
E		I A K L N S T							**1**
F		G D P R				D	G D P R		**3**
G					*F D W Y R P*	P F	F P R	F G Y P R	**4**
H	J	J						J	**3**
I		N A				*T A*		A	**3**
J	H Y					H D		H	**3**
K	L E Z			*M L E Z U T R P*		*P U Z*	L E Z U T	L Z T U	**5**
L		I E A T S N	*I E A T S N*		*I E A T S O N*			I A E N T	**4**
M				K Z U P	*K Z U R P*		K Z P R U		**3**
N						*I E A T S L*	I E A S T	I A S T	**3**
O	K E T			L K E Z U T		L Z		L E Z U	**4**
P	K M U	G D Z W U R M K				*K C Z U R M*	K M R U Z C		**4**
R	K M P U	K M P U Z		*G F D C Z Y U P M K*	*D C Z U P M K*	*K C M Z U P*	K M P Z U	K M P U Z C	**7**
S		I A N T	*I E A T N L*	I E A T N L		I E A T N L	I E A L N T	I E L A N T	**6**
T		D B A Y U N L K J I H	*E D B A Y U S N L J I*		*I E A Z O N L K*	D A Y S N L J I H		I E D A Y N L	**5**
U				E Z T P O L K		*K L M P Z*	E K L O T Z		**3**
W						G F D		F D Y P R	**2**
V			J H D B Y T	J H D B Y T				J D Y	**3**
Y						J H G D R P			**1**
Z	E K L U	K L E O T			*E U T P O L K*	K U		K L T U	**5**
Cum.	**8**	**13**	**6**	**9**	***6 ****	**16**	**10**	**17**	

The table lists distracters of the targets that have been 100% or 95% (*italics)* in Graphotable total playing time records, eg. Rudy has played target B with distracters J H Y and V with 100% performance and Ally has played target C with distracters K M P R U and Z at 95% performance. 100% performance in total playing time means that the player has not made a single error during the whole intervention with the target item, 95% performance usually means that there has been one or two mistakes, which is also very good performance. **General easiness of a target** can be read by looking at the amount of players who scored well with it, eg. target R has been the easiest target because 7 out of 8 players have played it 95-100% during their total playing time. In opposite way target Y has been difficult because only one player has been 100% perfect with it. **Knowledge of phonemes** can be seen when looking at the table case-wise: Edna has known most phonemes because 17/24 have been 100% during the whole game. In the opposite, Dinah has known only 6/24 phonemes perfectly in the game. This table indicates that targets A, E and Y have been most difficult in the game. *Note that Lily has not played

target items B, H, J and V at all.

Appendix 5: Comparison of alphabet code in English, Finnish and Cinyanja

	English letter name and pronunciation	Finnish letter name and IPA pronunciation	Finnish phoneme	Cinyanja phoneme	Cinyanja phonemes in English words
A	ay [ei]	Aa [a:]	/a/	/a/	as a in father
B	bee [bi:]	Bee [be:]	/b/	/b/	as b in babble
C	see [si:]	See [se:]	/s/	/tʃ/	as ch in chin
D	dee [di:]	Dee [de:]	/d/	/d/	as d in doubt
E	ee [i:]	Ee [e:]	/e/	/e/	as e in elbow
F	eff [ef]	Äf [æf]	/f/	/f/	as f in find
G	gee [d3i:]	Gee [ge:]	/g/	/g/	as g in good
H	aitch [eitʃ]	Hoo [ho:]	/h/	/h/	as h in hat
I	eye [ai]	Ii [i:]	/i/	/i/	as ee in meet
J	jay [d3ei]	Jii [ji:]	/j/	/d3/	as j in joke
K	kay [kei]	Koo [ko:]	/k/	/k/	as k in kid
L	el [el]	Äl [æl]	/l/	/l/	as l in last
M	em [em]	Äm [æm]	/m/	/m/	as m in mood
N	en [en]	Än [æn]	/n/	/n/	as n in near
O	ou [əu]	Oo [o:]	/o/	/o/	as o in boss
P	pee [pi:]	Pee [pe:]	/p/	/p/	as p in puppy
Q	cue [kju:]	Kuu [ku:]	/k/		(not in the game)
R	ar [a:*]	Är [ær]	/r/	/r/	as r in sorry
S	es [es]	Äs [æs]	/s/	/s/	as s in sun
T	tea [ti:]	Tee [te:]	/t/	/t/	as t in toe
U	u [ju:]	Uu [u:]	/u/	/u/	as oo in boot
V	vee [vi:]	Vee [ve:]	/v/	/v/	as v in verse
W	double-v [d^bəlju:]	Kaksois-vee [kaksoisve:]	/v/	/w/	as w in we (or wh in white)
X	eks [eks]	Äks [æks]	/ks/		(not in the game)
Y	why [wai]	Yy [y:]	/y/	/j/	as y in you
Z	zed [zed]	Tset [tset]	/ts/	/z/	as z in zoo
		(ng or n)	/ŋ/	/ŋ/	as ng in singing

The presentation of Zambian phonemes is inadequate due to lack of source materials. Dictionaries were of little help as they usually only said “pronounce the words exactly as they're written” (Khozi & Grant, 2000) or had descriptions such as “a as in far, father” (Hoch, 1960). The most elaborate source was Lehmann (2002) which gave detailed linguistic information about Cinyanja language but lacked a consistent mapping of phonemes and their spellings in IPA code. The contents of Sewero La-ma-u were

accepted by a language specialist from the Curriculum Development Centre. This table is compiled using Rubba (2003), Lehmann (2002), Mäkinen (2004), IPA code information and English letter names are from Wikipedia Internet encyclopedia.