JYU DISSERTATIONS 209

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# Assessing and Validating Early Grade Teachers' Knowledge of Vowel Letter Sounds of Transparent Zambian Bantu Languages Using Computer Based GraphoLearn Technology

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Esitetään Jyväskylän yliopiston kasvatustieteiden ja psykologian tiedekunnan suostumuksella julkisesti tarkastettavaksi syyskuun 17. päivänä 2020 klo 17.

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# ABSTRACT

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Teachers who instruct children how to read in transparent orthographies need to possess the knowledge of letter-sound correspondences critical in helping learners acquire basic reading skills. Lyytinen, Erskine, Kujala, Ojanen and Richardson (2009) observed that Zambian teachers lacked adequate information about this core knowledge for instructing reading in their transparent Zambian Bantu languages. The typical error has been caused by using letter-names of English, which fail to cue the sounds of the letters of Zambian Bantu languages such as; CiNyanja, one of the languages of initial literacy in Zambia. Ojanen et al. (2009) noted that Lusaka primary school children experienced difficulties in mapping letters to sounds in their fully consistently written Bantu languages and consequently failed to acquire the basic reading skills in the first grade in school.

The goals of this study were to (1) observe the situation of knowledge teachers have concerning efficient instruction of the basic reading skills of Bantu languages in Zambian primary schools, and (2) document how intervention based on GraphoLearn (GL) technology can help teachers acquire the core knowledge i.e. the sounds of letters – especially vowels sounds – needed for efficient instruction of the basic reading skill of Zambian Bantu languages. To attain these goals, this study was divided into four sub-studies. Study I examined the teacher trainers' and teachers' background knowledge needed for the efficient instruction of basic reading skills. Study II assessed the teachers' knowledge specifically associated with letters representing vowel sounds, using an experimental measurement tool to observe in which ways the teachers' knowledge of letter sounds was compromised. Study III observed using a Finnish-based digital learning environment GL, the accuracy and the confusion between vowel sounds collected and then validated such knowledge with that collected in study II using the measurement tools. Study IV documented how GL-based training supports a teacher's acquisition of the knowledge of vowel letters. Primary school teachers (N = 32) from Lusaka and Eastern Provinces; and teacher trainers (N = 22) from 11 colleges of education in Zambia participated in the study. Data were analysed using SPSS to generate descriptive statistics. The questionnaire was administered twice (before and after the use of GL). The results showed that teachers' knowledge of vowel letter sounds in general improved after training with GL (t = 3, 116, df (31); $p$ = .004) except for letter U. Vowel letter "I" emerged to be the most problematic sound in all the measures: Pre-test(65.63%), Post-test(80.00%) and GL(69.4%). Further, the findings indicated that most teacher trainers and teachers lacked sufficient background knowledge and information on reading instructions, especially of transparent Bantu languages. Overall, the findings suggest that majority of the teachers did not know all the vowel letter sounds perfectly well to instruct reading effectively and Finally, the results also suggest that GL training support acquisition of vowel letter-sound knowledge for teachers.

*Keywords:* Vowel letter sounds, assessment, reading instructions, transparent writings, GraphoLearn technology, orthography, teachers, teacher trainers, measurement tool.

# TIIVISTELMÄ (FINNISH ABSTRACT)

Yalukanda, Christopher Kyakukaisha
Sambian ala-asteen opettajien tietämys johdonmukaisesti kirjoitettujen Bantukielten vokaalikirjainten äännöstä: arviointi- ja validointitutkimus käyttäen tietokonepohjaista GraphoLearn teknologiaa

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Lasten lukemaan oppimista kirjain-äännetasolla johdonmukaisesti kirjoitetuissa kielissä opettavien tulee omata kirjainten vastinäännetuntemus. Lyytinen, Erskine, Kujala, Ojanen ja Richardson (2009) havaitsivat, että Sambian opettajille ei ollut riittävää tietoa tästä johdonmukaisesti kirjoitettujen Bantukielten ydinasiasta. Tyypillisen virheen aiheutti nojautuminen englannin kielen kirjainten nimiin, jotka eivät ohjaa oikeaan Sambian bantukielten, kuten esimerkiksi CiNyanjan, kirjainten ääntämiseen. CiNyanja on Lusakassa ja Sambian itäisissä provinsseissa asuvien lasten kieli, jolla lukemaan opettaminen alkaa. Sambian nykyopettajat ovat taipuvaisia seuraamaan opetuksessaan sitä mallia, jonka opettajat (vuoteen 2000 asti) itse oppivat koulu-uransa alkuvuosina, jolloin lukemaan opetus alkoi englannin kielestä. Ojanen ym. (2009) totesivat, että Lusakan ala-asteen oppilaat kokevat vaikeuksia kirjain-äännetasolla täysin johdonmukaisesti käyttäytyvän kielensä kirjoituksen vastinäänteiden oppimisessa. Sen vuoksi lapset epäonnistuvat lukemaan oppimisessaan ensimmäisillä luokilla kuten Sampa ym. (2019) sittemmin osoittivat.Tämän tutkimuksen tarkoitus oli 1) havainnoida tietoisuutta, mikä Sambian ala-asteen opettajilla on Bantukielten tehokkaasta instruoinnista, 2) dokumentoida mahdollisuuksia GraphoLearn (GL) teknologian avulla auttaa opettajia omaksumaan lukemaan oppimisen ydintieto, so. kirjainten äännevasteet, erityisesti vokaaliäänteiden osalta. Se auttaisi heitä instruoimaan tuloksellisesti Sambian Bantukielten lukemaan oppimisen perusteet. Saavuttaakseen mainitut tavoitteet tämä tutkimus on jaettu neljään tutkimusosioon. Tutkimus I tarkastelee ala-asteen opettajien ja opettajakouluttajien tehokasta peruslukutaidon opettamista koskevaa tietopohjaa. Tutkimus II arvioi opettajien erityisesti opettajien tietämystä kirjaimista, jotka edustavat vokaaliäänteitä käyttäen kokeilevaa, kevyttä arviointimenetelmää, mikä kehitettiin sen havainnoimiseen mitä puutteita tässä tietämyksessä on. Tutkimuksessa III käytettiin Suomessa kehitettyä digitaalista GraphoLearn teknologiaa, mikä havainnoi ja tallentaa pelinomaisessa ympäristössä kirjainten äännevasteiden tuntemuksen ja paljastaa sekaannukset, joita siinä havaitaan. Näin sillä voidaan validoida mainitun kyselypohjaisen (tutkimus II:n) menettelyn toimivuutta. Tutkimus IV dokumentoi sitä, miten GL-pohjainen harjoitus auttaa opettajia tuntemaan vokaaleja edustavien kirjainten äännevasteet virheettömästi. Tutkimus kohdistettiin ala-asteen opettajiin (N=32) Lusakasta ja itäisistä provinsseista sekä opettajakouluttajiin (N=22) yhdestätoista Sambian opettajakoulutuslaitoksesta. Kyselypohjainen kirjainäänten tunnistusmenettely esitettiin kahdesti (ennen ja jälkeen GL-menettelyn käyttöä). Tulokset osoittivat, että vokaaliäänteiden tuntemus parani GL-harjoituksen avulla ($p = .004$) lukuun ottamatta U-kirjaimen vastinäännettä. Ongelman tulkinnan perusteella odotetusti vaikeimmat ongelmat liittyivät I-kirjaimen äännevasteeseen molemmilla menetelmillä saaduissa tuloksissa. Lisäksi useimmilla opettajilla ja opettajakouluttajilla oli merkittäviä puutteita lukemaan opetusta koskevassa tietämyksessä, erityisesti johdonmukaisesti kirjoitettujen Bantukielten peruslukutaidon opettamiseen. Tulokset osoittavat, että enemmistö opettajista ei tunne kaikkien vokaalikirjainten oikeaa äännevastetta, ja että GL harjoitus tukee opettajien kirjainten äännevasteiden omaksumista.

*Avainsanat:* ortografia, transparentit kirjoitukset, peruslukutaidon opetus, vokaalikirjainten äännevasteet, GraphoLearn (GL) teknologia, mittausmenetelmät, opettajat, opettajakoulutettavat.

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# 1 INTRODUCTION

Reading is one of the most important language skills critical to both the academic and professional progression of an individual. Through reading, individuals can acquire knowledge and skills for personal and societal development. However, attaining literacy remains a major challenge to many learners in Africa (Lyytinen et al., 2019). But, because of the economic and social benefits associated with literacy, it is essential to prepare children to be effective readers from early grades. Children learn to read from different people (e.g. parents, siblings), but the role of a teacher is key because, unlike speaking, reading cannot be learnt naturally but through a well-structured process. Teachers of early grade learners must therefore possess both subject knowledge and pedagogical skills to be able to instruct reading effectively (Lyytinen et al., 2019; Macmillan, 1997; McCutchen et al., 2002; Moats & Foorman, 2003; Mulcahy et al., 2017; Spear-Swerling, 2009).

However, many teachers in Zambia are experiencing challenges providing quality reading instruction to learners because they learnt to read English as their first written language (Lyytinen et al., 2019). Since independence, Zambia has recorded a decline in literacy acquisition among school going children, e.g. in 2007, 44% of grade 6 learners assessed were functionally illiterate (Lyytinen et al., 2019). This is because many early grade teachers were inadequately informed about the differences between the phonics of English and the phonics of Zambian languages, and therefore continued to use English letter names in literacy instruction (Lyytinen et al., 2019; Ojanen et al., 2015). Recent studies have revealed that teachers of early grades in Zambia tend to teach letter names of the English alphabet when instructing initial literacy as opposed to letter names that are appropriate for the Zambian Bantu languages and their letter sounds (Lyytinen, 2014; Ojanen, 2009).

However, teaching the English alphabet is an inappropriate way of instructing reading in local transparent Zambian languages because of the differences in orthographic depth. Their teaching practice informs us that many teachers lack an understanding of the basic concept of transparent writing systems when instructing reading of the local languages (see MoGE, 2012). According to Lyytinen at el. (2019) the lack of scientific knowledge on language

development, literacy acquisition, and learning in general is a rarely mentioned challenge in the area of international development and yet, it is difficult to see how teacher training programs or production of teaching and learning materials could improve without a solid foundation in science (Lyytinen at el., 2019). Little is also known about the teacher trainers' and teacher's background knowledge on how to read local transparent written Bantu languages in Zambia. Teachers lack adequate knowledge of the letter sounds which is the key starting point to learning to read transparent Zambian local languages (Jere-Folotiya et al 2014; Ojanen et al., 2015). No documented studies available in Zambia have investigated the teacher trainers' and teachers' knowledge about reading instructions and vowel letter sounds of the transparent local languages.

This research thus investigates vowel letter sounds knowledge of early grade teachers using an experimental measurement questionnaire-based assessment and the GraphoLearn (GL) dynamic assessment as tools. The knowledge of vowel letter sounds plays a significant role in learning to read transparently written languages, such as Bantu languages in Zambia. Lyytinen et al. (2009) recommended that teachers lacking the core knowledge of letter sounds could benefit from computer-based training available through the GL application (app). According to Jere-Folotiya et al., (2014) in her assessment of first graders and their teachers in reading of letter-sounds of transparent Zambian Bantu languages, found that the best reading acquisition results were recorded when both the teacher and the child used the GraphoLearn (GL).

## 1.1 Multilingualism and Language Policy in Zambia

Zambia is a multilingual state with approximately 73 officially recognised tribes. According to Kashoki (1978); because many Zambians tend to identify language with a tribe, many believe that since there are 73 tribes, there are also 73 languages. However, Kashoki (1978) explains that, this confusion between language and tribe is partly due to the confusion between language and dialect. In a linguistic sense, the various tribes identify themselves by their way of speaking and their various ways of speaking may be considered regional dialects, although any slight change in the way of speaking is considered a different language by many Zambians.

Based on the linguistic grouping carried out by Kashoki (1978), it is reasonable to conclude that the number of languages spoken in Zambia is closer to 20. However, the Zambian government enacted a new language policy in 1966, choosing English as the national official language; the government officials believed that having English as a neutral language would play a unifying role in a newly independent multilingual state of Zambia (MoE, 1971). English was then adopted as a medium of instruction from grade 5 to tertiary education. According to Mwanakatwe (1973), the proponents for the introduction of English as a medium of instruction argued that it would be easier to use it because it was a

language of technology, knowledge and written materials in it were readily available, and this could facilitate easy concept formation from an early age. However, research has shown that learning to read in a familiar language or mother tongue is much easier and faster than in a foreign language (Abadzi, 2013; McGuiness, 2005; Trudell, 2008; UNESCO, 2007). Trudell (2008) argued that local language literacy necessitates communication, facilitates educational achievement and links school to communities, hence making learners feel more at home. However, the Zambian government adopted seven official regional languages as medium of instruction from grades 1 to 4 in their respective regions (MoE, 1970). These local languages were namely: Icibemba, Silozi, Kiikaonde, Luvale, Chitonga, CiNyanja and Lunda, were taught as subjects from grades 5 to 7 in their respective regions until 1970, when a new curriculum called English media course or experimental version was introduced.

After 30 years of experimenting with the medium of English in classroom instructions in Zambian schools, it became evident towards the end of 1990 that Zambian primary school children were experiencing difficulties acquiring basic literacy skills (MoE, 1996). This situation raised serious concerns among stakeholders and Government officials, and in 1995, the Ministry of General Education (MoGE) constituted the National Reading Committee to follow up on issues related to reading and to propose better ways of improving reading performance in Zambia (Linehan, 2005). After examining the reading difficulties and identifying the use of English as one of the contributory factors; the National Reading Committee proposed measures to reverse the declining literacy levels. The National Reading Committee recommended re-introducing the use of mother tongue-Zambian languages from grades 1 to 7. The National Reading Committee also recommended considering Zambian languages as one of the subjects to be used as a criterion for selection to the next grade-8 and reiterated the importance of using mother tongue to introduce basic reading skills.

## 1.2 History of reading instructions in Zambia

In 1971, a new English Media Course called Zambia Primary Course (ZPC) was introduced into all public primary schools to reinforce the use of English as a medium of instruction starting from the first grade to tertiary education level. Under this programme, all subjects were to be taught in English. This course was intended to make those completing primary school proficient in the use of English as well as to give them the lexis and structures necessary to understand, and use it in other areas of the school curriculum taught in the medium of English (Kashoki, 1978). It was further hoped that children who advanced to higher grades were well prepared to take advantage of the available opportunities and also future challenges (MoE, 1971).

The principle method of instructing reading and language learning was the whole word (look and say) approach, which was influenced by the behaviourists

(MoE, 1977). Behaviourist believed that environmental factors influenced language learning especially in the first language. They also identified reinforcement as key in learning to read e.g. associating words with meaning. Under this approach language learning was viewed more of a mechanical process that involved storing word images, which is considered effective if the learner first stores the spoken words that they can then connect to their written forms. Teaching of sight words was a major route to early reading acquisition (Ehri, 2005), and children were expected to accumulate and recognise a large amount of whole words or vocabulary (Goswami, 1986). Teachers were trained to instruct children to read words as whole units without using phonics, i.e. making children aware of the phonemes of English which are inconsequential when learning to read in transparent written languages, e.g. local Bantu languages, the languages children already speak in a country like Zambia. The learners were subjected to repeated practice through drills, while being shown the printed word version on either a word card, flashcard or on the board, until they automatised the words. The students were then taught to master or memorise the structure of a word in real situations or context, and asked to recognise the words by their shape or formation. Children were made to associate words with pictures or within a meaningful situation – a real situation or context. Learning to read progressed from dealing with relatively large units (whole) to eventually smaller units (parts) such as letters and sounds, and learning to read was considered a natural phenomenon.

This method was ineffective for the Zambian learners because Bantu languages have consistent orthographies in terms of letter sounds, and the learner needed only to master the letter-sound connections to be able read (Lyytinen et al 2009; Lyytinen, 2014). This method also neglected teaching phonemic awareness in the initial stages which is necessary when learning to read in local transparent written languages. Phonemic awareness (i.e. learning the sounds connected to letters/graphemes) facilitates the development decoding skills which in turn help learners to decode new words in transparent writing (Aro, 2005; Ehri, 2005). Critics of the whole word approach (Look and Say) argue that this approach is responsible for the reading challenges learners experience today and that it contributes to the decline in reading standards in Zambian primary schools.

Another prominent feature of the ZPC was the use of the syllabic method. This method involves decoding multi-syllable words to help learners to discover how to divide words into decodable parts (Diliberto et al., 2009; Shefelbine, 1990); this method works best when learning how to read English because such segments are chosen to behave consistently. Teaching syllable patterns helps learners to recognise similar chunks of print while reading, and subsequently help in automatisation of word recognition and spellings (Diliberto et al., 2009; Moats, 2000). However, no specific rules and patterns governing the structures of Zambian Languages were taught and only examples of rules and patterns adopted from English language were given to help learners begin connecting examples to other words, following the same phonetic patterns. The learners

were taught to cluster consonants with vowels to form syllables, which were then blended to make words. The other feature of the ZPC was reading aloud; following the teacher's example, children read aloud to internalise the words without even knowing the meaning of the words. Furthermore, Hulme and Snowling (2013) stated that learning to read aloud created in the memory, an association between the printed form of the word and its pronunciation.

Despite the introduction of the ZPC, reading and the general standards of education began to decline towards the end of 1970 because the learners could not master English easily, concept formation became difficult in a foreign language, and reading was not guaranteed because the new language and its orthography had no consistency in its vowel system. The emphasis on the use of English resulted in the school becoming 'an alien' institution within the community (Mwanakatwe, 1974), which led to a strong dislike of school and increased absenteeism among pupils (Mwanakatwe, 1974) because their lack of understanding of English meant they could not participate in the learning process.

In the 1996 Education Policy document, 'Educating Our Future', the government began to observe some negative impact of using a foreign language to introduce initial literacy (MoE, 1996). Like Trudell (2008) and (Kashoki, 1978), proponents of the use of mother tongue when learning to read argued that using a second language as an official language would distance the learning content from the realities of the community. It could also render learning irrelevant in the local context. Other studies (Abadzi, 2013; Nunan, 1999) have also revealed that children's early reading development and comprehension are more easily achieved in their first language context than in their second acquired languages, which is especially true for transparent writing systems.

In 1986, a new basic education system was introduced in Zambia in response to the declining education standards and the reading levels. This new education system meant the transformation of the school structure to (grade 1 to grade 9), from (grade 1 to 7), thus necessitating a review to the school curriculum and in the teacher training. The Zambia Basic Education Course (ZBEC) was introduced in 1992 to address the needs of the new school system and was anchored on a new approach to language teaching called Communicative Language Teaching (CLT). Under this approach, language was considered as a means of communication and not a system of grammatical structures and rules (MoE, 1992). An integrated approach to teaching reading became the main feature. Reading and writing were developed and reinforced by the listening and speaking skills (MoE, 2002). This course accorded teachers some freedom and flexibility to organise their work, promoted creativity and innovation. It emphasised the teaching of writing and spelling because it was believed that learning to write is learning how to spell. Graham et al. (2002) contended that mastering spelling was essential to both writing and reading, and that writing facilitates the acquisition of basic reading skills such as word attack and word recognition.

The new course recognised a phonic approach to instructing reading to support traditional methods (MoE 1992), the new approach emphasized the teaching of letter-sound relationships, blending those sounds into words and reading those words in the connected text (MoE, 1992). However, incompatible with that, the whole word approach remained the principle method of instructing reading among most teachers who had learned to read English during their early school years, despite its inadequacies.

## 1.3 Current Literacy Situation in Zambia (2019)

Despite a number of reforms and interventions, the Government of the Republic of Zambia (GRZ) has reported that most young Zambian learners are still reading below 62.2%, the levels initially envisaged during the Basic Education Sub-Sector Project-BESSIP (MoE, 2000). Research has shown that learners with reading challenges in early grades are at risk of performing poorly academically, and may experience social emotional and behavioural problems and may not progress further in school (Lesnick, George, Smithgal, & Wynne, 2010., Mugnaini et al.,2009).

The UNESCO Report (2008) put Zambian illiteracy rates at 70% overall and 84.6% in the rural areas, which is further supported by the findings from both regional and national assessments. The findings have consistently shown that children are failing to reach desirable or satisfactory levels in reading in Zambian languages and in English at grades 2, 5 and 6 (EGRA, 2014., MEVSTEE, 2012, 2014., MoE, 2006, 2008, 2010., SACMEQII, 2007, SACMEQIII, 2011). The National Assessment Report (MoE, 2008) showed that the national mean percentage mark in reading is 34.5% in English and 37.8% in Zambian languages at the middle school basic level. These results indicate that less than 40% of the children are reading accurately and the majority are unable to read at desirable levels in either English or the local Bantu languages.

Furthermore, Early Grade Reading Assessment (EGRA, 2014) results at grade 2 level also revealed very poor reading comprehension and fluency. In addition, these results further highlighted a general decline in learner mean performance in basic reading skills, and across all subject areas including reading in English and Zambian Languages, except for a slight improvement in mean performance scores in Zambian Languages in 2014 compared to the previous surveys. Even more disturbing is the most recent finding of Sampa et al. (2018) which reveals that very few learners have even mastered the basic knowledge associated with reading the language they speak at the end of the second grade.

Ojanen, Richardson and Lyytinen (2009) demonstrated how Lusaka children face particular difficulties learning the sounds which are incompatible with those sounds cued by the letter names used in English. The low performance in reading has also been attributed to the use of inappropriate instructional methods and other reading related matters; inadequate teaching and learning

materials; and inadequate time, language policies, teacher training programmes and teacher background knowledge (Lyytinen et al 2019; MoE, 2012).

In view of the challenges, the Government of the Republic of Zambia (GRZ) instituted a number of strategic measures and reforms to reverse the language policy which recognised English as the official medium of instruction from 1966. The guidelines from the Government have varied over the past years but none has made a significant effect. Teachers do not know how to provide the instruction because they lacked sufficient information and knowledge of the most effective ways of teaching the basic reading skills in Zambian transparent languages. Such languages could be easily be learned using methods involving phonic-based instructions, which is used for instance by GraphoLearn- GL.

## 1.4 Alphabetic Writing Systems and Learning to Reading

### 1.4.1 Orthography and reading acquisition

Seymour, Aro, & Erskine (2003), in a comparative study of language acquisition in Europe found that orthographic differences influenced reading acquisition because of variations in the number of graphemes–phoneme correspondences to be learnt in the individual languages. In alphabetic writing systems, languages are classified as either shallow or deep because of their consistency, regularity or transparency of their orthography at the level of letter sounds correspondence (Aro, 2005; Lyytinen et al 2006; Seymour, Aro, & Erskine 2003). Shallow or transparent writing systems are those languages whose letter-sound correspondences relate one on one while opaque or less transparent writings are those languages which have one or more variations at grapheme–phoneme relations.

The consistency of connections between letters (or two letter graphemes) and phonemes in transparent languages means a small number of variations (Aro, 2005, Lyytinen et al., 2009), which makes it easy to acquire the basic reading skills. Learning to read means the learner should understand how written symbols connect to speech sounds that they already know. According to Richardson and Lyytinen (2014), when learning to read in transparent writings one needed to memorise the connections between the letters of the alphabet and the sounds associated to them. This would help to decode and pronounce words easily, in that language and invent meaning.

In opaque writings like English, letter sounds are inconsistent and less transparent, which means that the letter names do not always cue the same sound in all contexts. The sound may vary depending on the position where the letter occurs in a word. Compared to Finnish and Zambian Bantu languages, English vowels are especially complex and inconsistent, and they can be pronounced in a number of different ways depending on the contexts. Sometimes the names tend to be misleading such as in the case of vowel letter I, whose name is incompatible with the most common sound it represents in English, namely /i/,

mainly due to its very frequent occurrence before letter 'n'. One letter can sound differently in different contexts of writing and sometimes in a complex way (i.e. not always the same even before an 'n' letter, e.g. the letter I in minute and minus).

The irregularity of the orthography affects the speed of acquiring basic reading skills (Aro & Wimmer, 2003). In transparent languages, the number of consistent connections to be learned are much fewer and easier to acquire as opposed to those of less consistency writing systems such as English. For example, in Zambian Bantu languages there are between 28 to 30 connections (Ohannessian and Kashoki 1978), while in English there are likely more than 1,000 connections. This difference shows that different learning times are needed for acquiring the basic reading skills in those two types of orthographies; it takes much longer to acquire basic reading skills in English compared to transparent writing systems such as Finnish language and Bantu languages of Zambia, the focus of this study.

### 1.4.2 Features of Zambian Bantu languages

According to Ohannessian & Kashoki (1978) Zambian languages have phonological similarities which are anchored on five vowel letters/graphemes(a,e,i,o,u) corresponding perfectly to five sounds(phonemes). The vowels in Zambian bantu languages are pronounced the same regardless of the location or position they are found in the words except where fusion or vowel lengthening occurs, e.g. vowels can fuse at morpheme boundaries between prefixes and stems such between the prefix nominal(noun) class 2(*antu*) and the stem -*ana*(child) which becomes *abaana*(children). Fusion or coalescence can also result in creating a new vowel -consonant, different from those fusing as in the word *mu*+*ana* which becomes *mwana* 'child' in Kiikaonde language. Vowel lengthening alters meanings of words spelt and pronounced the same, for example, *jina*(five) and *jiina*(toe) in Kiikaonde language. In the first instance a short vowel is applied and in the second, there is vowel lengthening changing the meaning completely.

One unique characteristic of Zambian languages is vowel harmony which deals with verbal extensions. Vowels in the suffix extension changes to correspond to at least one phonological feature to the one in the verb root, e.g. *bik*-a(keep) or *bik-ay-i* (keep for) in Kiikaonde language. Because of the presence of the mid back vowel/a/ in the root in the high front vowel/i/, the extension has to harmonise to the vowel height of /a/ and becomes a mid-front/i/. In addition, most Zambian language are tonal, and this helps to distinguish the meaning of one word or phrase spelt the same, while English language relies on stress. e.g. in /a/ as in hat, /e/ as in red or /i/ as in sit. This occurs mostly when a vowel is followed by a consonant in a short word as illustrated above. According to Mwansa (2017) beginning readers of Zambian languages need to be equipped with the knowledge of vowel lengthening early in order to understand the process responsible for change in vowel lengthening and, teachers

responsible for instructing reading in Zambian languages should be empowered with this knowledge during initial teacher training.

Consonants, like vowels are very important in learning to read of Zambian Bantu languages because the combination of vowels and consonants form the foundation for phoneme and syllables, which plays a key role in learning to read in transparent languages. Research has shown that learners experience difficulties decoding words with consonant clusters (Kaani & Joshi, 2013). There are between 28 to 30 consonant phonemes if we only consider single consonants and digraphs in Zambian Bantu languages (Kashoki, 1978). Consonants, such as 'x' and 'q' are not in use in Zambian Bantu languages. The commonly used consonant clusters in Zambian languages are called digraphs: sh, ch, dz,ny, ng,zh,th,ts,pf and ng').

In addition, Zambian Bantu language are known to be syllabic in nature. A syllable is a salient phonological unit in Zambian languages made up of an onset and a rime. The onset is a consonant or cluster preceding a vowel while the rime is the vowel. The rime is further segmented into the nucleus(vowel) and the coda, the consonants after the vowel. In Zambian languages syllables are usually open and have no coda, which make them simpler to pronounced compared to English. There are four types of syllables in use, with clusters in their onset; vowel(v), consonant+vowel(cv), consonant+consonant+vowel(ccv) or consonant +consonant +consonant+vowel(cccv). The structure of syllables in Zambian Bantu languages makes word pronunciation and word recognition easy because of the straight forward letter sounds correspondence like in Finnish language (see Aro, 2004, Lyytinen et al 2006). In English, syllables are more complex than in Zambian Bantu languages because they are closed and end with the coda. There would be probably 15000 syllables in English given that there are 24 consonants and 15 vowels (Frost, 2005) which means that if English was using a syllabic writing system, there would be about 15000 unique symbols to recall. Despite the above, syllables are critical in learning to read in both transparent and non transparent languages.

According to Ohannessian & Kashoki (1978) the consistence of vowel letters sounds; the syllable structure and the consonant clusters make Zambian Bantu languages structures different to that of English. For example, in English such combinations as; *kn* in know, *ky* as in sky, *rhy* as in *rhyme*, *sks* as in *risks*, are permissible but not in Zambian Bantu languages, without inserting a vowel between consonants. Further, the structure of sounds and sound combination or clusters are sequenced in a word or sentences to express special proportional to words that they have in common.

In Bantu languages a single verb can express a full clause or sentence containing close to 11 inflections or derivational affixes apart from the root in the same discource. e.g. *Ba-le-mu-afw-a(baleemwafwa)* in Icibemba, which Means, '*they will help him'* (English). In short, Bantu languages are agglutinative in nature because most words are made up of more than one morpheme expressing semantic and grammatical information bound together. While English is typically an isolating language as noted in the sentence above. In most Zambian

Bantu languages, the syllable is a significant phonological unit which meets with grammatical morpheme on the margins/borderlines.

And Lastly, most Zambian languages are written conjunctively whereby morphemes are blended into words, except for Silozi language, where disjunctive elements have been noted, attributed to the influence of French Missionaries (Kashoki, 1978).

### 1.4.3 Instructing Reading in Transparent Zambian Languages.

Because of the orthographic nature and characteristics of most Zambian Bantu languages (see chapter 1.4.1 and 1.4.2), Phonemic awareness is an important pre-requisite to the development of letter-sound knowledge and thus, helps learners to realise that spoken words are made up of separate sounds. Lyytinen et al. (2009), observed that learners who did not know and understand basic principles of phonemic awareness faced challenges in acquiring basic reading skills in transparent writing systems effectively.

Once a learner acquires the basic letter sound correspondences and phonemic assembly skills, they are able to practically read new words or pseudowords they come across in transparent writing systems (Aro, 2005; Lyytinen et al., 2009; McGuiness, 2005). Learners need to store the sounds of each of letter (or grapheme) and learn how to blend the sounds together in the order of the letters/graphemes. According to Castle et al (2018), attaining the grapheme phoneme knowledge does not occur naturally to children, like learning to speak, but must be taught explicitly and doing so is important for making progress in reading.

To help children to learn to read in transparent writings such as bantu languages, there are at least two scientifically supported ways. The first is for learners to learn to master the letter-sound connections to help them decipher any new word by connecting the sounds in the order of the letters (graphemes). Learners can implement this process without knowing the meaning of the assembled word, using a phonic-based approach (synthetic), which focuses on grapheme–phoneme correspondences. According to Share (2008), mastery of a letter sounds relationship is key to the decoding process in consistent languages for learning to read because this allows learners access to any word, including those whose meaning they do not know in their spoken language without having to memorise the written forms of all the words (Lyytinen et al., 2009).

The second way is to learn the speech sounds in the context of the word (analytical approach), learners analyse the similarities and differences between words in terms of the sounds they contain and infer from them, e.g. in KiiKaonde language, one of the seven regional languages in Zambia, the word 'moona' (see) and 'mona' (nose) have similar sounds except for the middle sound, which distinguishes the meaning of the two word. Children can learn the meanings of new words quickly by reading them from material containing a picture informing them of the meaning. In transparent writings like Finnish, similar to Zambian Bantu languages, the spelling system is not complicated and, according to Lyytinen et al. (2009), in such writing systems, the letter-sound connections

can be drilled efficiently. Thus, with an effective, initial focus on the sounds of the graphemes, learners would be successful in literature-rich activities and they could learn to decode words fluently by continuing to read after learning the connections.

For attainment of full literacy- fluency and comprehension in transparent writing systems like Zambian Bantu languages, the most optimal way is to use one's decoding skill, i.e. reading sufficiently will lead to automatisation. Lyytinen (2005) noted that in most transparent writing systems, letter-sounds knowledge should not pose a problem; but only the attainment of fluency becomes the main challenge, especially for those with compromised skills to acquire literacy. This is because the number of connections between sounds and letters that children need to learn are fewer and one has to master a larger number of connection building operations to read fluently in transparent writings (Lyytinen et al., 2009). Furthermore, fluency also provides a firm basis for the comprehension of text because the time taken to read the sentence is effective for keeping the content in the working memory for comprehension. This is echoed by Aro and Wimmer (2003) who contend that, the acquisition of accurate phonological coding has fewer challenges in more transparent writing systems, which means that only the acquisition of reading fluency becomes the main developmental focus. Thus, a sufficient amount of reading can help in the automatisation process; however, this may be a challenge for children who have faced difficulties acquiring accurate decoding skills because it may have weakened their motivation to read, hence weakening the chance that automatisation will happen.

The obstacles learners face while reaching accurate reading skills tend to lower their motivation to read, and one of the key challenges for any teacher is retaining their interest and motivation to read. However, doing so naturally requires a content which is exciting enough to read so that the learner really wants to read it with comprehension. Once a teacher understands the principles of effective instruction to help children build a strong foundation for reading, good results should be attained easily. Studies have revealed that the rate of developing basic decoding skills is quicker in children learning transparent writing systems/orthographies than in opaque writings, in addition to the higher accuracy in reading both words and non-words (Lyytinen at el 2006; Seymour, Aro, & Erskine, 2003;). Holopainen et al. (2001) argue that using phonic method reinforces grapheme–phoneme correspondence and makes children aware of phonemes. Because when learning to read, learners need to acquire basic working knowledge of the major letter sound correspondences which is vital for word processing. Direct instruction is also necessary because the grapho-phonic system is particularly complicated for most early grade readers and especially for readers who are disabled, to navigate on their own (Ehri & McCormick, 1998). Explicit phonics instruction of letter–sound correspondences should thus be taught in a way that links the correspondences to how they appear in specific words.

Phonic method has historically been the source of controversy, however careful consideration of research concerning this approach points to the benefits, when it is carried out appropriately, meaning that when children's own spoken language is written in a consistent way, it is wise to start the reading instruction using smaller units such as letter- sounds(Ehri & McCormick, 1998). Therefore, teaching letter- sounds(phonics) gives learners the skills to translate orthography into phonology and thereby to access knowledge about meaning (Castle et al. 2018). As such, following the ways of teaching English may fails to lead to desirable results for children learning to read in regular writing systems, e.g. Bantu languages in Zambia.

### 1.4.4 Learning to read in Non-Transparent English Language

According to MoGE (1998) once learners have acquired basic literacy skills in local familiar languages, they can then transfer these skills in a second language. In case of Zambia, transition from initial literacy in local languages to English occurs in the 4th grade. It is important for teachers of literacy in early grades to understand the process of instructing reading in English (Binks- Cantrell at al., 2012; Lyytinen et al., 2009).

In Linguistics, English language is described as a language with high orthographic complexity because of its irregularity and known inconsistency in its letter-sound correspondences. This poses serious challenges for those learning to read English. English has multiple sounds for a single letter, thus requiring a learner to master a large number of connections to be able to read (see Frost, 2005). The simple way of instructing reading in English works best by viewing learning as a connection building task, such that learning is focused on appropriately large segments/units which behave consistently. The process of learning to read in English should therefore involve the creation of mappings between orthographic and phonological representations. Reading English can be learned after one has mastered or accumulated sufficient vocabulary (English words), which means that direct instructions using larger units than a single letter or phoneme is required to decode English. One can learn such connections in English language because they are consistent and usually form units as large as rimes. Phonological awareness, which is the ability to recognise and manipulate sounds in its spoken language is thus, critical to learning to read in English. Holopainen et al. (2002) identified phonological representation as significant linguistic precursor to learning to read in less transparent writing systems. "If phonological awareness is not effectively taught to young children, learning to read in English becomes an impossible task" (Moats and Foorman, 2003, p. 39).

Lyytinen (2005) explained that all instructions on reading acquisition based on English models follow a dual processing route for word recognition. The route one is using analogy (Ehris, 2005; Goswami, 1986), which is anchored on the phonological process of grapheme-phoneme translation. Learners can call upon their previously accrued knowledge of orthographical units to work out how unfamiliar words are read and spelt (Goswami, 1986), such as the frequent

spellings patterns of rime in words such as sat, cat, fat, mat and flat, which is problematic because none of the letters represent only one phoneme in English. According to Goswami (1986, 1988) and also Holopainen (2002), an analogy approach that also utilise a phonic approach, is one easy way to learn to read in less transparent languages like English.

The second route requires the learner to learn orthographic images of the whole word that one is able to sound out or recognise, which is also known as sight word recognition (Aro, 2005; Ehri, 2005; McCormick, 1998;). Reading instructions in English are thus usually a use combination of Sight/Whole word and phonic approach. Just like learning to read in transparent writing systems, learning in English also requires the knowledge of each letter/ grapheme, or (a group of letters instead of one letter) in a word that can be associated with a particular sound. However, because it varies, one has to start from the basic principle of teaching building blocks between the spoken and written form the consistent units, which means that only units that are larger than one letter units have to be used to have consistently learnable connections. The learner's task is to memorise the full orthographic sequences such as; a word, or in words in phrases or short sentences, which places the focus on the meaning of the words ((Ehri, 2005; Richardson and Lyytinen., 2014).

Research has also shown that exclusively following Whole word method can impact negatively on the memory of the learner, and learning of new words becomes an overload on young learners (Ehri, 2005). Seymour, Aro and Erskine (2003) noted that learning to read in non-transparent writings like English at the foundation level should involve identifying and storing familiar words in through automatisation or "sight" which the children can retrieve from memory or recognise upon seeing the word. To achieve this a learner requires a full understanding of the writing system-orthographic knowledge, and attain fluency with larger units of letter-sound correspondences such as rimes, the alphabetic process and the skills to decode letters into sound.

## 1.5 Effective Reading Instructions and Teachers' Knowledge

For decades, researchers in psychology and education have debated on the most effective method of instructing reading in initial stages. Two main approaches have emerged, phonic and whole word approach. This debate has come to be known as the reading wars. Aro, (2003); Castle et al., (2018); Holopainen et al., (2001), and Seymour, Aro, and Erskine, (2003) have shown that language specific properties such as morphological and phonological features influence orthographies. As discussed already (see Chapter 1.4.1), orthographic depth of a languages plays a key role in reading acquisition and influence reading instruction methods. According to Castles et al (2018), transparent languages makes it easy for the sounds to be mastered in memory because they are fewer in numbers and graphemes map one on one with phonemes. Since orthographies

of transparent writing systems are not complex, direct instruction of letter sounds correspondences beginning with the smallest reading pronounceable unit-phoneme fits well using the phonic approach. In deeper orthographies, reading instructions can start by teaching larger units such as rhymes, syllable or sight words because of the huge number of grapheme-phoneme or digraphs available (see Chapter 1.4.1). This will help learners decipher words in English easily and therefore reading instruction in such languages should focus on developing phonological awareness using whole word approach.

McGuiness (2014) and Lyytinen et al. (2009) documented phonemic awareness as the single most powerful predictor of children's reading skills in transparent languages, which is also important in less transparent languages when it comes to the vowels, although very few of these – particularly 'I' – behave in a consistent way. The development of phonemic awareness arises during initial literacy instructions. The straight forward grapheme-phoneme correspondences in Zambian languages help in fostering the letter-sound knowledge of children. This can be done using phoneme awareness tasks such as phonemic identification, segmentation and deletion tasks (McGuiness, 2014). Effective teaching of transparent writing systems guarantees accurate decoding skills during early grades, from which children can approach full literacy (including reading comprehension), simply by reading enough. Studies have shown that first-grade learners who received systematic instructions in letter-sound correspondences improved in word reading and spelling accuracy faster than learners who did not receive such instruction (Treiman, 1998).

The challenges of today's teachers in Zambia are associated with their use of English instructional methods, which start with the use of letters used in English, and the language policy that was adopted when they received instruction in school. The whole word or sight approaches have been mainly adopted for instructing reading because it works for the English language, after learning a sufficient amount of spoken English, but not in transparent writings of local Zambian languages, which require teaching letter-sound connections. Holopainen et al. (2001) documents this process as being critical in learning to read consistently in written languages. However, most of the reading research literature is based on observing the acquisition of skills needed to read English; which is not a universal model for reading instruction (Aro, 2006; Seymour, Aro and; Share, 2008). Some studies have associated differential natures of effective instruction in each type of alphabetic writing as one of the factors that contributes to children learning to read (Bos et al., 2001; Hulme & Snowling, 2011). Teachers' knowledge of instructional strategies in alphabet writing systems can influence learner's knowledge in reading and writing (Moats & Foorman, 2003; Snow et al., 2005; Moats, 1994).

Thus, teachers in Zambia could be using instructional methods based on teaching English to instruct literacy during the post-independence era, methods not appropriate for instructing reading in transparent Bantu languages. Since reading acquisition is based on building connections between the written and spoken language, it is very important that, when teaching reading, sounds of the

language have to be familiar to the learner. Instead of teaching letter sounds of Bantu languages, Zambian teachers taught the letter names of the English alphabet (Ojanen et al., 2009). The alphabet song is a typical example of how children learn the letter names in Zambian schools. Richardson and Lyytinen (2014) recommended for a synthetic phonic approach to instructing reading in transparent orthographies because it takes into consideration the psycholinguistic grain size of a specific target language and uses sub lexical information in less transparent writings mixed with the phonic method. Effective instructions therefore help to determine the extent to which teachers provide quality literacy experiences to learners. Research has further shown that the method of instruction learners receives impacts on their reading development, and this requires a teacher with a strong base of foundation skills, and the ability to identify instructional needs of learners (Al-Hazza, Fleener, & Hager, 2008). Teachers who do not possess such knowledge as, phonemic awareness principles (McGuiness, 2005; Lyytinen et al., 2009), the sounds of the grapheme needed for instructing transparent writings, or to instruct reading in less consistent orthographies face a huge task in scaffolding reading skills (Ehris & McCormick, 1998).

## 1.6 Interventions to Improve Literacy Instructions in Zambian Primary Schools

Arising from the recommendations of the National Reading Committee Forum of 1995, and new scientific evidence available on reading acquisition and instructions, the newly formulated national education policy of 1966 called '*Educating Our Future*' cited English as a major contributing factor in fostering rote learning. From the onset, "children had challenges in associating the printed forms of words with their real and underlying meaning" (MoE, 1996, p. 39). Following the introduction of the new language policy a new reading programme called the Primary Reading Programme (PRP)was first piloted in selected public primary schools in 1998 and subsequently rolled out to all public primary schools in 2000. Its main feature was the teaching of initial literacy in mother tongue or familiar local languages.

### 1.6.1 Primary Reading Programme 1998 to 2013

In 1998, a new teacher education course, Zambia Teacher Education Course (ZATEC), was introduced to replace the ZBEC. According to MoGE (2008), this course was designed to implement a new basic education curriculum that reflected accurately the contemporary needs of Zambia. The course integrated the traditional subjects into six core study areas with emphasis on a localisation of the school curriculum that was relevant and responsive to local needs and times (MoE, 2008). In the new curriculum, the primacy of literacy, numeracy and a number of cross-cutting themes/issues that had been identified as central to the

future development of Zambia were recognised (MoE, 2008). e.g. gender, climate, school health/nutrition, Immuno-deficient syndrome HIV/Aids

The main feature of the new curriculum was a literacy programme called the PRP. This programme introduced initial literacy skills to learners in early grades (Grades 1 to 4) in mother tongue or familiar local languages. The programme came with new methodologies which offered teachers a more independent style of learning, equipped them with knowledge in the subject areas and developed their competencies and skills in teaching (MoE, 1998). The programme stressed the active participation of learners in the learning process and encouraged the development and appropriate use of a wide range of resources. The programme further aimed to develop the teachers' competencies in planning, implementing and evaluating children's learning effectively and taking into consideration the needs of the country, the community, the school and the learner; teacher education in this case plays a critical role in developing the pre-requisite knowledge, early in the teaching career.

This course trained teachers to teach learners the sounds of the letters by teaching the sound of the day. Learning to read then started by eliciting the key sentence of the day from a conversation chat or poster, which was then segmented into words, syllables and the smaller unit of a phoneme (MoGE, 2001). Much emphasis was placed on teaching the letter sounds beginning with a larger unit like sentences which were then segmented into smaller parts such as rimes, syllables and phonemes. Despite rolling out the PRP into all public schools in the country in 2000, many children in early grades could not read at acceptable levels, this is evident from various assessment reports (MoE, 2008, 2010, 2012, MESVTEE 2014, SACMEQ, 2010).

### 1.6.2 Primary Literacy Programme (PLP 2015 to date)

In 2015, a New Literacy Framework called the Primary Literacy Programme (PLP) was introduced to address concerns raised in the local, regional and international assessment findings (MESVTEE, 2014; SACMEQ, 2007, SACMEQ 2010; USAID, 2016), which showed learner achievement in reading to be below grade level. The new programme consolidated the use of mother tongue/familiar languages in the teaching of initial literacy in early grades. The background to the introduction of teaching in a local language is rooted in scientific research that consistently shows that learning in mother tongue languages supports the development of a learner's language abilities, including their vocabulary, intrinsic knowledge of grammatical rules; the speed and ease at which a learner can do this in their own language surpasses that in a foreign language (Lyytinen et al., 2009; Trudell, 2008). The other important factor that necessitated the introduction of the PLP was the recognition of research findings from countries such as Finland and other countries which have documented the effect of orthographic depth in reading acquisition. The consistency and regularity in writing reduces the learning burden compared to that found in less consistently written writings such as English.

The new framework emphasises systematic instruction of sounds to ensure all learners acquire the basic knowledge before progressing to the next step. In PLP, instructions began with teaching pre-reading skills, letter sounds correspondences, sound blending and syllables, and it progresses to teach other components of language such as words, phrases and sentences. Pre-reading skills and sounds are taught daily through phonemic awareness and phonics to build a strong foundation for decoding skills. In the first-year, a synthetic approach to teaching phonics is adopted for teaching letter sounds in a sequence of most frequently used sounds, e.g. vowel letter sounds in their language (MESVTEE, 2014); and this is then followed by blending known letters to form syllables and syllables to form words and subsequently words to form sentences. Literacy instruction focuses on providing children a chance to practice reading common words in sentences to foster oral reading fluency.

Based on the new literacy framework, an approach to Early Grade Literacy was designed for grades 1-7. This programme incorporates nine components of reading considered important for successful reading development: (1) pre-reading and pre-writing, (2) sounds – phonemic awareness, (3) phonics, (4) words, (5) sentences, (6) comprehension, (7) writing, (8) punctuation and (9) fluency. Taken together these components build a learner's ability to read, write, speak and listen – all necessary skills for literacy development (MEVSTEE, 2014).

## 1.7 Education Technology – Computer Assisted Instructions

### 1.7.1 Computer-based support for reading acquisition and instructions

The last decade has witnessed unprecedented technological advancements in the education sector both in Zambia and globally, thus supporting classroom instructions and learning. These advancements have given new impetus and hope to teachers, educationist, researchers, policymakers, administrators, learners and many other stakeholders such as parents. Education technology is helping in supporting the learning process and delivering the learning content efficiently, for example, computer assisted instructions (CAI) such as integrated learning systems use multimedia platforms for instructing reading, thus making it easy for both teachers and learners to learn in their own time, hence optimising learning time and opportunities. Studies have shown that digital devices available today, such as computers, tablets and smart phones are adaptive to individual needs and also motivating to learners. New technology can further mimic some of the behaviour of expert human instructors or teachers (Adam & Wild, 1997; Gina B & Gina G, 2012; Lyytinen et al., 2009). Gina B and Gina G (2012) conceptualised technology as affordable tools teachers can use, in their quest to help young learners to attain higher levels of literacy skills as demanded by today's information-based society. The availability of digital devices has altered the teacher's and learner's ways of teaching and learning. These technologies

support acquisition of reading skills and knowledge that is needed by learners learning to read and those who have learnt to read (Gina B and Gina G, 2012).

However, when embracing new technology in education, caution must be applied. Technology must be user-friendly in terms of interfaces and portability of content between devices. There is also need for timely skilled responses to technical challenges associated with new technology (Gina, B and Gina G, 2012). As the new technology becomes readily available and accessible, teachers must also be prepared to cope with the new technology. This is important in accelerating teachers' learning curves and helps them focus on classroom instruction. In Zambia, information on the best approaches to support professional development of teachers in the use of computers is almost absent in most primary schools. Most teachers' knowledge on the use of technology for teaching has been acquired through independent learning rather than formalised training. The majority of the Zambian teachers may not be adequately prepared to handle the new technology to support reading instructions and general classroom practices as most primary schools lack the appropriate technology and internet connectivity because of the associated costs related to procurement.

### 1.7.2 GraphoLearn (GL)

GL is a computer-based game that can be used as a teaching and learning tool by teachers and learners to enhance the core knowledge of letter sound correspondences through repeated practice. This computer-based game was developed by a group of scientists and scholars at the University of Jyväskylä and Niilo Maki Institute (NMI) in Finland. The game assists learners to master the letter sounds easily and in an enjoyable way. Richardson and Lyytinen (2014) revealed that Finnish children, who have difficulties reading, typically struggle at first with learning the simple grapheme–phoneme correspondence. However, GL has proved to be useful for such learners. It is effective in supporting children's reading acquisition in Finland and in other languages with transparent orthographies (Folotiya et al., 2014; Lyytinen et al., 2009; Richardson and Lyytinen, 2014). Its efficacy has been documented in studies conducted in Zambia (Jere-Folotiya et al., 2014., Ojanen, 2009., in Kenya-Puhakka (2015)., in Namibia-February (2018) and in Finland (Richardson and Lyytinen (2015).

Computer based-work can help learners improve academically beside motivation. This technology plays an important role in building self-confidence skills in addition to motivating the learners as well (Adam and Wild, 1997., Gina B and Gina G, 2012). The GL component of the reading programme uses applications that can keep records of the player logs, the assessment tasks and the children's competency levels for the different skills. This information helps teachers or parents to monitor the child's progress (Lyytinen et al 2009). The benefit of using computer-based learning and teaching such as GL is that performance information is recorded for future adaptation. Adam and Wild (1997) explained that the computer-based environment has in most cases multiple representational platforms that can be manipulated and controlled to break the monotony from traditional classroom practices, thus motivating

learners., e.g. by touching, hearing, seeing, constructing, playing and replaying auditory constructs, computer-based learning has significant potential for assisting young children's reading skills acquisition.

Gina, B and Gina, G (2012) acknowledge that computer-based learning can also be highly individualised and a learner's performance can be monitored closely, and this could be especially helpful to children at-risk. In Finnish, as in the Bantu family of Zambian languages, single letters map onto phonemes in a regular manner. After the basic letter sounds are learned, phonemic blending skill is required for mastering basic recoding. In Finnish, this phonological assembly is a fairly straight forward and simple serial process of combining the letter sounds in sequence (Lyytinen et al., 2006; Lyytinen et al., 2008). In addition, computerised training can be used to demonstrate how phonemes blend into syllables and the syllables into words to provide learners an opportunity to discover and practice the assembly strategies (Aro, 2004). To ensure that the connections between the printed items and their phonological counterparts are learned, the learners practice these correspondences until they succeed in choosing the correct item three consecutive times. A play-like element is also created by time-limiting the exposure of the options, which aims to accelerate the speed of making the correct connections between phonological and orthographic representations (Lyytinen et al., 2008; Lyytinen et al., 2009).

# 2 THE AIM OF THE RESEARCH

This study has four main aims. The first aim is to investigate teacher trainers' and teachers' backgrounds and subject knowledge in reading instruction for transparent Zambian orthographies. Obtaining this information is important because the background and subject knowledge plays a key role in the actual classroom practice. The second aim was to investigate in which ways the Zambian early grade teachers' knowledge of vowel letter sounds is compromised using a multiple experimental measurement tool. Letter sounds is central to learning to read transparent languages (Ehris, 2005; Lyytinen et al., 2009).

The third aim was to investigate how a Finnish-based digital learning environment- GL technology collects game logs, which provides information on the teacher's knowledge of vowel letter sounds and confusion with other letter sounds. GL helps learners to acquire basic letter-sound knowledge by asking users to repeatedly choose the correct letter from the alternatives, one of which represents the sound they hear in the headphones while playing the game. Once they have mastered the grapheme–phonemes connections, most learners are able to sound out letters and read new words.

While, the fourth aim was to observe whether teachers benefit from receiving GL training support to learn the key skills and the vowel letter sounds needed for instructing basic reading skills of transparent writing systems. The game logs of the GL can be used to compare the assessment scores from the questionnaire based experimental measurement tool (pre and post) to investigate their ability to decode transparent Bantu words. GL is expected to boost users' knowledge (vowels) of reading which helps in reinforcing the knowledge of both the learners and the teachers, thus helping them to acquire the optimal way to instruct basic reading skills to their Zambian learners.

It was hypothesised that teacher trainers and teachers lacked adequate background and core knowledge of vowel letter sounds related to instructing reading in transparent written Zambian languages. The two-measurement tools – experimental questionnaires and GL – are used to investigate the ways in which the teachers' knowledge of vowel letter sounds is compromised, and how

training using GL supports acquisition of the key vowel letter-sound knowledge needed for the optimal instruction of reading.

The study is guided by four research questions:

1. What are the teacher trainers' and teachers' background and subject knowledge about reading instruction in transparent written Zambian Languages?
2. Can teachers' knowledge of vowel letter sounds be assessed using a questionnaire-based experimental measurement tool to investigate the ways in which it is compromised?
3. Can teachers' knowledge of vowel letter sounds be observed from game logs generated by the computer-based -GL to find out in which ways teachers' knowledge of vowel letter sounds is compromised, and whether GL can confirm the observations of such knowledge collected using the experimental measurement questionnaire tool?
4. Can the GL intervention support the training of teachers' vowel letter-sound knowledge and help to optimise their skills to instruct basic reading skills?

# 3 STUDY I TEACHER TRAINERS AND TEACHERS' BACKGROUND KNOWLEDGE ABOUT READING INSTRUCTIONS IN ZAMBIAN TRANSPARENT WRITINGS

## 3.1 Introduction

Information about teacher trainers and teachers background/subject knowledge on literacy instructions and development is very important because it is helpful for identifying characteristics that reflect their qualifications, experience, knowledge, pedagogical and expertise (McCardle and Chhabra, 2004). However, many studies have shown that teacher educators and teachers lack adequate background knowledge on literacy instructions and development which provides successful classroom instructions (Binks-Cantrell et al., 2012; Spear Swerling and Bucker, 2004) because colleges of education may not be training their trainee teachers on the basic concepts necessary to instruct literacy (Binks-Cantrell et al., 2012 ; Joshi et al.,2009; Walsh, Glaser and Wilcox, (2006). Binks-Cantrell et al (2012) and Washburn, Joshi, and Binks-Cantrell (2011a). attribute poor classroom instructions to a lack of basic understanding of concepts by those charged with the responsibility to instruct the trainee teachers and learners.

This study investigated teacher trainers' and teachers' background information and subject knowledge about reading instructions in transparent writing systems because Zambian Bantu languages are all written in a transparent way, and many of them are sufficiently similar to help children acquire basic reading skills, even though it might not be the language the child speaks daily outside of school. This study further explores the variations and potential impacts of the teachers' background information and subject knowledge and considers it in relation to the data collected about the teacher's readiness to instruct reading in familiar Zambian languages. Teacher trainers

and teachers' background information and subject knowledge of the local languages impact positively to the learners' reading development. For example, Al-Hazza et al. (2009) acknowledged that teachers who are well inform in several content domains, e.g. in phonology, morphology, semantics, syntax, phonics and pragmatics play a significance role in helping children learning to read, but (Binks-Cantrell et al., 2012) noted that knowledge alone does not seem to improve learners' reading achievement unless teachers applied it in their instructions.

## 3.2 The aim of the study

This study aimed at investigating the teacher trainers' and teachers' background information and subject knowledge about the reading instruction of the transparent written languages, which is the first step to instructing reading skills in local Zambian languages. The hypothesis is that teacher trainers themselves may not be well versed with the basic concepts of language structure relating to reading acquisition of transparent writing systems and that teachers also lacked this knowledge because it is likely they did not acquire it during initial teacher training, and neither have optimal knowledge of how to instruct the reading of English most efficiently.

The specific research questions for this study were:

i. What are the teacher trainers' and early grade teachers' views on the reading approaches for transparent written Zambian languages?
ii. What are the qualifications and teaching experiences of both the teacher trainers and teachers?
iii. What are the teacher trainers' and teachers' views about letter sounds of transparent and less transparent written languages?
iv. What do the teacher trainers and teachers consider to be the most important steps in instructing reading in local Zambian transparent writings?
v. What are the teacher trainers' and early grade teachers' views on the availability of teaching and learning materials, computer assisted training and instructional time to literacy in Zambian primary schools and colleges of education?
vi. How do teacher trainers and early grade teachers view the use of written materials in local languages outside of schools and access to training for reading instruction?
vii. Which order of instructing components for guiding children to acquire the reading skill in local languages is preferred by teacher trainers and early grade teachers in Zambia?

## 3.3 Ethical considerations

The teachers selected for this study were those who had been left out of earlier studies conducted by Reading Support to Zambian Children (RESUZ) in Lusaka or Read to Succeed in the Eastern provinces of Zambia. The preamble in the teacher questionnaire gave assurance to the teachers involved about the confidentiality of the data collected, confirming that it would be used for research purposes only.

## 3.4 Participants

The participants were 22 teacher trainers (Females=5, Males=17) and 36 early grade teachers. The teacher trainers mean age was 44.56(SD = 5.488) and the mean experience in teacher education was 2.29(SD = 1.056). The teacher trainers were selected from 10 public colleges of education offering training to primary school teachers in 10 provinces of Zambia. Given the low number of teacher trainers specialised in teaching literacy and languages. All data collected from all the participants was utilised because of the smaller sample size in this study rather than applying random sampling, which is used in studies in large populations. The sample in this study represents only teacher trainers who taught literacy and languages from 10 colleges of education in Zambia. All the teacher trainers (100%) had a university degree qualification and most possessed other qualifications as well. The highest qualification was a masters' degree. The minimum required qualification for teaching in a college of education training primary school teachers in Zambia is a first-class degree.

While 36 teachers from Lusaka and Eastern provinces originally filled in the teacher background information questionnaires, only data from 32 teachers (Female=10, Male=22) were analysed in this section because four teachers were excluded for missing values in the second assessment. There were 14 early grade teachers from Lusaka district and 18 early grade teachers from Chipata, Katete and Lundazi districts. Table 1, presents the mean and standard deviations of the teachers' age, teaching experiences years, gender and course duration.

Table 1 Mean and SD for Teaching Experience, Age and Course Duration

| Variable | No. | M | SD |
|---|---|---|---|
| Age | 32 | 34.19 | 5,781 |
| Teaching Experience | 32 | 7.56 | 5,464 |
| Duration of Training | 32 | 2.32 | 6,616 |

The majority of teachers had a primary school teaching certificate called ZATEC. In addition, more than half the teachers (50%) also possessed a diploma in primary school teaching (see Figure 1).

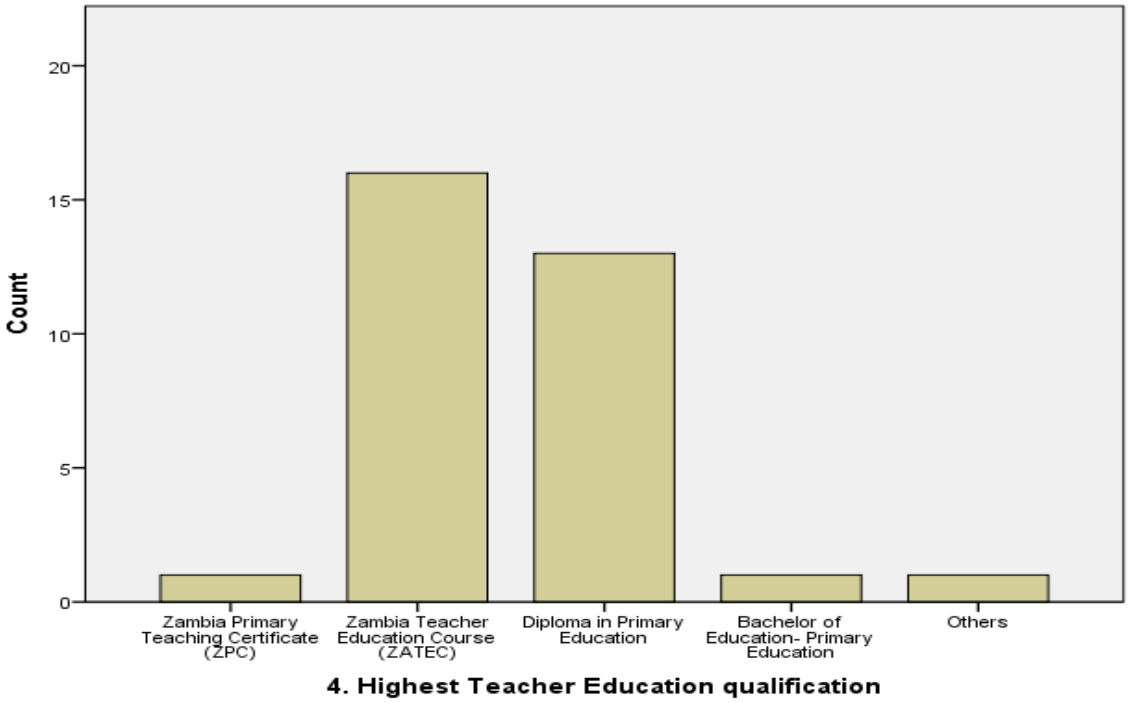


Figure 1 Teacher education professional qualifications.

Notably, the teachers in this sample were likely to be more informed on matters related to reading instructions than their colleagues who did not attend the workshop, because they had received a short orientation in the basic knowledge on reading instruction during workshops organised by Center for the Promotion of Literacy in Sub-Sahara Africa (CAPOLSA) and supported by the Universities of Zambia and Jyvaskyla. Lusaka-based teachers (N = 14) had a two-day orientation workshop organised at the University of Zambia and the teachers in Eastern Province attended a one-day orientation workshop that was organised in each of the districts.

In all the selected districts, CiNyanja was the medium of instruction and the language of initial literacy from grades one to four. Figure 2 shows the mother tongue languages of teachers in the study. Of the teachers, 57.5% were native speakers of CiNyanja and 86.5% used native languages to instruct basic initial reading skills in their classrooms.

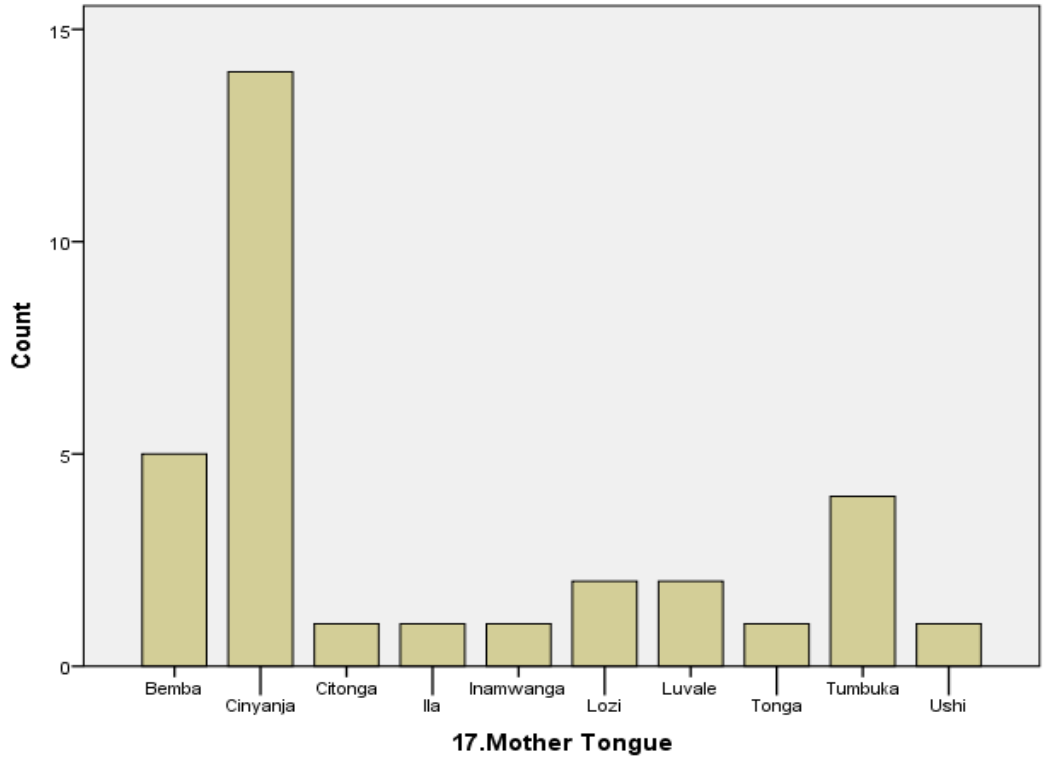


Figure 2 The teachers' mother tongues.

## 3.5 Context of the study

The schools were selected because CiNyanja is used as a medium of instruction and language of initial literacy in the school, and that the schools had previous association with either RESUZ in Lusaka or Read to Succeed in Eastern Province, respectively. Lusaka schools were considered for their urban setting, and Eastern schools were considered for their rural setting. In Lusaka, diverse of languages, including English, are spoken by most families at home, which means that most children in Lusaka might not use CiNyanja as their home languages. In Chipata and Katete, Chichewa is the language widely used, while Tumbuka is home language in Lundazi.

## 3.6 Research design

This experimental measurement tool–questionnaire-based study was associated with other connected studies – i.e. assessments and interventions of the teachers' letter knowledge – which were made based on GL after the teachers had completed the questionnaire. A complete set of such studies provides a better

opportunity to judge in which way the teachers' core knowledge of vowel letter sounds is compromised for proper reading acquisition.

## 3.7 Data collection

In this study data collected using two questionnaires designed by the researcher to obtain the teacher trainers and teachers' background information and subject knowledge (Appendix 9 for teacher trainers and Appendix 10 for teachers). The background information questionnaire was created to obtain additional information about the teachers' educational and professional qualifications, continuing professional development, mother tongue and teaching experiences, methods of instructions, knowledge about reading instructions and the new literacy framework in Zambia. The two questionnaires obtained the needed data about the teacher trainers and teachers' biographic information and subject knowledge about literacy teaching and learning practices in the early grades.

Furthermore, the questionnaires had each a section that assessed the teachers' self-reported practices on how they instructed reading. The questionnaire asked the teachers to categorise how much time they allocated (measured in hours) to the instruction of reading in their school and whether it was sufficient. Additional questions required teachers to indicate the steps followed when instructing reading to learners in the first grade. The teachers used many of the literacy strategies mentioned in both instruments to help learners learn to read during the early grades.

To ensure that the needed reliable and sound responses were elicited, Derrington's (2009) guidelines were followed. Derrington (2009) recommends for more than one reviewer to screen the questionnaires for clarity and appropriateness to conform to the research question and context. To meet this criterion, a linguist and two curriculum development specialists from Zambia's Curriculum Development Centre (CDC), who were experts in languages, reading development, classroom instructions and early literacy were engaged to evaluate the questions. Each reviewer was requested to read the questions for clarity and determine whether they would elicit the desired results to answer the research goals. Furthermore, the questionnaires were piloted in Lusaka with first-grade teachers and at Chalimbana Colleges of Education for lecturers to ensure clarity and eliminate undesirable questions or statements. The feedback from the pilot study helped to perfect the questionnaires. Data from the colleges of education were collected using a questionnaire (Appendix 10) designed by the researcher and piloted at Chalimbana College of Education.

Data were collected from the teacher between February and March 2013 by research assistants in Lusaka during the mentioned orientation workshop of CAPOLSA and in Eastern Province. The questionnaires were administered to the teachers between September and November 2014 at their respective schools by research assistants. The research assistants were trained in how to perform the

data collection at the University of Zambia. The workshop helped to ensure that the questionnaires were all collected on site, since the sample size was small. In Eastern Province, the research assistant administered the questionnaire to teachers individually. Teachers were contacted through the office the District Education Board Secretaries and the headteachers of the respective schools.

The questionnaire, which was designed in the context of an earlier study (Folotiya-Jere et al, 2014), focused on the assessment of children's reading skill which included an intervention using GL to help understand the effects of school instruction for reading in Zambia. The questionnaire comprised 35 questions in two sections. Section A contained 26 questions collecting biographic data and section B contained nine questions associated with reading knowledge-related content. The questionnaire was divided into three sections. Two lecturers belonging to the literacy and language study area of each college of education that volunteered to respond to the questionnaire also returned the questionnaires to the researcher through research assistants at each college. Section A of the questionnaire collected biographic information, Section B collected information concerning reading instruction and Section C collected information about how teachers viewed teaching of reading instruction in the colleges of education. Data from the colleges of education were collected using a questionnaire (Appendix 10) designed by the researcher and piloted at Chalimbana College of Education.

## 3.8 Data analysis

SPSS version 22 was used to generate descriptive frequencies such as the mean, standard deviations and percentage distributions to analyse the teacher trainers' and teachers' background and subject knowledge of reading-related matters.

# 4 STUDY II. ASSESSING THE VOWEL LETTER-SOUND KNOWLEDGE OF EARLY GRADE TEACHERS USING AN EXPERIMENTAL BASED MEASUREMENT TOOL

## 4.1 Introduction

This study assessed the vowel letter-sound knowledge of early grade teachers in the same settings as those described in Study I. Teachers entrusted with the responsibility of instructing reading in transparent languages need to understand the core knowledge of letter sounds, especially vowel letter sounds, which combine with consonants in most Zambian Bantu languages to form words. This knowledge is essential when teaching and learning to read in alphabetic languages (Adams, 1990; Ehri, 1998; Treiman, 2006), and is especially important in writing which are transparent at the grapheme–phoneme level, such as most of the African local languages where it forms the core knowledge. Becoming aware of phonemes, i.e. sounds of the letters or their combinations, is the starting point for reading (Bos et al., 2001; Lyytinen et al., 2006).

According to Holopainen et al. (2002), knowledge of grapheme–phoneme correspondences and mastery of phonemic assembly can be effective tools for decoding any kind of word in the last-mentioned writing contexts. Bos et al. (2001) recommended that teachers needed to poses knowledge of letter-sound correspondences, which is a positive predictor of early word reading; therefore, teachers need to know how to use teaching methodologies and instructional programmes that have basic instruction in phonemic awareness as foundational elements. Additionally, the knowledge of the names of vowels and consonant letters and their sounds is highly predictive in transparent languages if these are given in an optimal way such as made in Finnish (e.g. Lyytinen et al., 2009), unlike in English where, for example, the letter I is named in a way that does not

hint towards the phoneme that it most commonly represents in several contexts of writing.

## 4.2 The aim of the study

Study II assessed the teachers' knowledge of the vowel letter sounds using an experimental measurement tool developed by the researcher. The study focused on vowel letters because they are important in transparent writings and are easy to sound out and differentiate from other letters of the alphabet. Vowels also influence how syllables and words are pronounced, especially in Bantu languages. Consequently, most of the names given to them are represented by the same letter name as the sound they represent in transparent writings. The hypothesis was that early grade teachers are not accurately informed about the vowel letter sounds of local Zambian languages. This knowledge is assessed using an experimental measurement tool–questionnaire developed for this purpose, which is validated in the next study.

The specific aims were to:

i. find out how accurately informed are the early grade teachers in Zambia about the vowel letter-sound correspondences of local Bantu languages such as CiNyanja.
ii. investigate in which ways the vowel letter-sound knowledge of teachers is most commonly compromised using an experimental measurement tool.

## 4.3 Ethical considerations

The teachers selected for this study were those who had not participated in the earlier studies conducted by RESUZ which instructed the names and sounds of the letters to teachers in Lusaka and the Read to Succeed (USAID project) in the Eastern Province of Zambia in their schools. This study thus gave an opportunity to teachers left out from earlier studies. The preamble in the teacher questionnaire gave assurance of the confidentiality of the data collected advising that it would be used solely for research purposes. Authority to collect data from teachers was obtained from the MoGE in Zambia through RESUZ.

## 4.4 Participants

The participants were 32 teachers (14 from Eastern and 18 from Lusaka provinces in Zambia) who filled in the Teacher background questionnaires. The mean age and teaching experience of the teachers were 34.48 years and 7.8 years

respectively. While the mean for the course duration was 2.34years. Half of the teachers (50%) possessed a minimum of a diploma primary teaching qualification. All the teachers in the study received an orientation in the basic knowledge of reading instruction during workshops organised by CAPOLSA, supported by the University of Zambia and the University of Jyväskylä. For Lusaka based teachers (N = 14), a two-day orientation workshop was organised at the University of Zambia. In Eastern Province, a one-day workshop was organised in each district by the research project leader and a research assistant. The participants were selected from schools whose teachers and pupils had participated in an earlier study conducted by RESUZ or CAPOLSA in Lusaka province and Read to Succeed in Eastern Province. In all districts, CiNyanja was the medium of instruction and initial literacy. Table 1 and Figure 1 in Study I show a full description of the characteristics of the participants. The majority of the teachers (93.3%) used CiNyanja as a medium of instructing literacy in their classes.

## 4.5 Context of the study (see study 1 for the description of the context).

## 4.6 Assessment method

Because of the absence of a standardised assessment tool for measuring the teachers' letter-sound knowledge, the researcher developed a letter-sound experimental measurement tool (Appendix 11) specifically to assess the teachers' vowel letter-sound knowledge. The participants were required to choose the occurrence of the assessment items (i.e. sounds of CiNyanja vowel letters) from the alternative English words provided, which contained the sound heard through the headphone. English words were randomly selected for this purpose from MoGE (Grade one Learners' book and Teachers' guides) designed by the Curriculum Development Centre (CDC). The content of the experimental measurement tool was evaluated with the help of Ulla Richardson (professor and expert of phonetics in Finland) and two language specialists from the CDC in the Ministry of General Education in Zambia. The assessment tool originally contained 50 items. After evaluation, two items – 'pure' and 'cat' – were dropped because of their inability to contain the intended sound of the CiNyanja vowel letters. The teacher was required to choose one of 48 alternative English words (following each letter) which contained a similar sound represented by a CiNyanja letter. The focus here is on vowel letters because of their ability in the English language to cause confusion between the letter-sound knowledge and their letter names (which is well known and often recited in Zambia; Ojanen et al., 2009).

The responses of the participants which were considered incorrect if the chosen word did not have the sound of the letter in question or the participants failed to choose from any of the responses provided. The response was deemed correct when the word containing the correct sound was selected and when any word not including the correct sound was not selected. The responses (choices) according to their correctness were then counted to build different statistical indices of the vowel letter-sound knowledge as summarised in the results section. The summary indexes scores were the total pre-test and total post-test, and the pre-test and post-test scores of the individual letter sounds.

## 4.7 Data collection

All 32 teachers were administered the assessment questionnaires twice, the first time before exposure to the GL and the second time after exposure to the GL. For Lusaka-based teachers, the assessment was administered in September 2014 at the beginning (pre-test) of the two-day orientation workshop held at the University of Zambia before exposure to GL. However, for teachers based in Eastern Province (N = 18), the pre-test assessment was conducted during the one-day workshop held in each district in October 2014 before the workshop-related teaching started. Only those teachers who filled in the teacher background questionnaire participated in the assessment tests.

Data for the post-test assessment for Lusaka teachers was administered at the end of the two-day workshop held at the University of Zambia in August 2014 and for Eastern Province based teachers, the post-test assessments were administered to individual teachers at their respective schools by researcher assistants in October 2014.

## 4.8 Data analysis

Data for the 32 teachers were analysed using SPSS version 22 to obtain descriptive frequencies and percentages. The variables from the pre-test (A, E, I, O, U) were computed separately to make new variables: correctly marked and correctly unmarked. These variables were then computed separately to create two new sum variables. The first was the total pre-test and the second was correctly unmarked. Both were computed over choices made for each vowel letter (A, E, I, O, U). A similar process was followed to create the post-test variables after the GL intervention.

# 5 STUDY III: OBSERVING AND VALIDATING THE QUESTIONNAIRE-BASED VOWEL LETTER-SOUND KNOWLEDGE OF TEACHERS USING GL

## 5.1 Introduction

The knowledge of vowel letter-sounds is very important for teachers instructing reading, especially in transparent writing systems. Little information is available on how this knowledge can be observed or measured. This study observed and validated the vowel letter-sound knowledge of the teachers using GL to find out in which ways their knowledge was compromised. As already explained in chapter 2, knowledge of letter sounds is an important pre-requisite in teaching as well as in learning to read in transparent writing systems (See Chapter 1.4). Therefore, teachers tasked with teaching children how to read in transparent writing systems need to master the grapheme–phoneme connections (Folotiya-Jere at el 2014; Lyytinen, 2006; Lyytinen et al 2009). Currently, schools are adopting computer-based technology to ease knowledge and skills acquisition.

Computers can install applications and software that can be helpful and relevant to the instruction of reading skills (see chapter 1.7.1). These applications can be available for use in low-cost mobile phones or in computers which are now found almost everywhere. Teachers who are insufficiently equipped and lack the knowledge of letter sounds can benefit from GL, a computer-based technology developed at the University of Jyväskylä, to enhance their letter-sound knowledge by just playing for a few minutes.

## 5.2 The aim of the study

This study had two aims; the first was to observe in which ways the letter sound knowledge of teachers is compromised using GL. The second aim was to validate using GL the letter sound knowledge of teachers measured using an experimental measurement tool designed by the research in study II. The hypothesis of study was that GL can be used to observe teachers' knowledge of vowel letter sounds in transparent writings and can validate results from the experimental measurement tool questionnaire in study II to determine whether GL supports training of teachers with compromised knowledge. The specific aims of the study were to:

i. Assess and validate the teachers' vowel letter-sound knowledge using GL, and
ii. Determine in which ways the teachers' knowledge of vowel letter sounds is compromised by using GL.

## 5.3 Ethical considerations

The teachers selected for this study were those who had not previously participated or used GL in the earlier studies conducted by RESUZ in Lusaka and Read to Succeed in the Eastern Province of Zambia. This study gave an opportunity for teachers left out from earlier studies to participate. The preamble in the teacher questionnaire gave assurance to the teachers involved about the confidentiality of the data collected, confirming that it would be used for research purposes only. The data on the server can only be accessed by using username and thus only authorised persons can access the information.

## 5.4 Participants

The participants were as described in Study II. Only teachers that attended the orientation workshop, responded to all teacher questionnaires and who were assessed in both the pre- and post-intervention assessments of the letter sounds played GL.

## 5.5 Context of the study

The teachers (N = 32) played GL as described above. Those selected were teachers that met the criteria described in Studies II and III. It was also a predominate language in these districts except for Lundazi, where Tumbuka was the familiar

language. Lusaka is an urban area and the capital city of Zambia; it is a somewhat multilingual district, with various languages spoken as home languages. Many children in the Lusaka urban area use English as their home language.

## 5.6 Research design-Grapho Game Intervention

GL (see www.grapholearn.com) is a computer-based game designed by researchers at the University of Jyväskylä and Niilo Mäki Institute in Finland, to support training of letter-sound knowledge. GL presents alternative letters on balls which fall at the same time that the learner hears a spoken sound represented by one of those letters. The task of the learner is to choose the letter from the alternatives corresponding to the sound they hear. The game motivates the learner to find the correct connection between each sound and the corresponding letter until the connections start being reliably stored by the learner. The game adapts to the individual learner and their situation in learning by providing continual feedback. Subsequent trials are introduced when about 80% of the choices the player makes are correct (based on data from earlier trials). The of task of the learner is to associate the relevant orthographic unit with the corresponding phonological unit. The major focus is building connections between single speech sounds (phonemes) and letters (graphemes), and later on introduce syllables and words.

The intervention involved teachers(N=32), purposefully selected using the criteria set in Study II, for teachers who received training using GL. Lusaka-based teachers played for two days divided into four sessions lasting 15 minutes each, and Eastern province-based teachers played one session of 15 minutes per day for 15 days. The initial planned play time was at least two hours, which was enough for a teacher to learn the vowel letter-sounds; however, this was not achieved by any of the teachers. The longest exposure time was 72 minutes while the mean play time was 30 minutes. The shorter play time is attributed to practical challenges, such as lack of electricity, internet connectivity and other technical problems as associated with new technology. The pre- and post-intervention assessments were conducted before and after the GL interventions.

## 5.7 Data collection

The data for this study were obtained from using different game versions installed on two different gadgets, Samsung Android and Nokia Lumia X phones. The mobile phones were installed with GL CiNyanja Version, eBooks and instructional videos. All 32 teachers received either a Samsung-Android or Nokia X-Lumia depending on the area in which they were based (Lusaka = Samsung Android, Eastern = Nokia X Lumia). Each phone had internet connectivity. As the teachers played the game, the game logs were generated from the mobile

phones and transmitted to the central server in Finland. The game logs from these gadgets were stored on separate files on the server and both phones had different sets of variables. Each teacher was identified by a GL code. All the teachers were supplied with headphones. Each teacher was asked to play the game to strengthen their skills knowledge in phonemic awareness, which is the core knowledge for learning to reading. Lusaka-based teachers were required to play for at least for an hour every day for two days for Eastern Province-based teachers were asked to play for 15 minutes per day for 14 days.

## 5.8 Data analysis

The game logs can be analysed using several computer programs, each of which has different features and methods of measuring. For this purposes data from each phone type were opened in Excel format in SPSS and merged into four files: (i) 230615- chrisdroidassessmentmerged.Sav.,(ii) 2306-chrisdroidphonememerged. Sav., (iii) 2306-chrisnokiaassessmentmerged. Sav and (iv) 230615-chrisnokiaphonememerged. Sav. A rural teacher, who played the Android game was moved from the Android group to the Nokia group to ensure that merging did not affect the variables. All rural teachers used the Nokia phone. The Android file indicated that the rural teacher had been taken off the file.

To arrive at the percentages of correct trials for the players, the calculations were made from the total trial number and the total correct selection number. GraphoLearn counted the correct and incorrect answers a player made from each trial in each playing session; this information provided statistical information on the player's performance, while Letter-confusion were generated from matrix graphs to check the confusability rates or levels. The matrix had different boxes with different shades of colours at the intersection of the target letter and distractor. The darker the colour at the intersect, the higher the level of confusion in the selection (see Appendix 9). The letter-sound test result tables were copied as pictures and added as new variables, which included the amount of letter-sound assessments for each teacher, and how many correct and incorrect responses there were for each target letter. This information gave the percentage of the accurate letter-sound knowledge for the entire game period (See Table 8) in the following results section.

# 6 STUDY IV: CAN THE GRAPHOLEARN INTERVENTION CORRECT THE TEACHERS' COMPROMISED VOWEL LETTER-SOUND KNOWLEDGE?

## 6.1 Introduction

This study compared the vowel letter sounds knowledge of teachers before and after intervention with GL. GL collects information of players' responses to each letter or syllable, as they played the game (see chapter 1.7). The focus of this study was on vowel letter-sounds because of their role in learning to read (Ehris, 1998; Lyytinen et al., 2009; McGuiness, 2005; Treiman, 2006), and needed thereafter for further learning, if the training continues over a prolonged period. The intervention time provided in this research was two hours, may be too short. This study aimed to find out how and in which ways the teachers' vowel letter-sound knowledge improved after exposure to GL. This study compared the pre- and post-intervention assessments to find out if training with GL supports acquisition of vowel letter-sound knowledge by the teachers. The hypothesis of the study was that GL supports the training the teachers' vowel letter-sound knowledge.

## 6.2 The specific aims of the study were;

The specific aims were;

i. to investigate in which ways teacher's knowledge of vowel letter-sounds can benefit from GL training.
ii. to compare the results of the pre and post intervention assessments to find out if teachers' knowledge of vowel letter sounds improved after exposure to GL

## 6.3 Ethical considerations

See Studies II and III.

## 6.4 Participants

See Studies II and III.

## 6.5 Context of the study

See Study I for the description of the context.

## 6.6 Assessment method

The assessments results were those from the pre and post intervention and GL. The teachers(N=32), purposefully selected using the criteria set in Study II,

## 6.7 Data collection

All 32 teachers who participated in the teacher questionnaires, the pre-intervention assessment and GL were administered the assessment questionnaires. For the Lusaka-based teachers (14), the assessment test was administered in September 2014 at the end (post-test) of the two-day orientation workshop held at the University of Zambia before their exposure to GL. However, for Eastern Province-based teachers (N = 18), the post assessment was conducted at the teachers' respective schools in each district in November 2014.

## 6.8 Data analysis

Data for the 32 teachers were analysed using SPSS version 22 to obtain descriptive frequencies and percentages. The variables from the pre-test (A, E, I, O, U) were separately computed to make new variables, which were then computed separately to create two new sum variables, total pre-test and total post-test. Similarly, the total post-test scores were computed, and the variables for correctly marked and correctly unmarked were created for each individual

vowel letter (A, E, I, O, U). To generate statistical data and the mean differences, standard deviation and *p*-values of the total pre- and post-test scores, the t-test was applied.

# 7 RESULTS SECTION

## 7.1 Study I:

### 7.1.1 Teacher trainers background knowledge of reading instruction

In terms of instructing reading of transparent languages, 63.6% of the teacher trainers preferred the whole word and say method over the phonic method (54.5%). Additionally, 72.7% considered teaching the names of letters using the methods followed in English as the first step in reading instruction, 68.2% indicated teaching the sounds of letters as the second step, and 66.75% of the teacher trainers preferred to teach letter sounds in each subsequent lesson until learners knew all the sounds (see Table 2).

Table 2 Preferred Method of Instructing Reading in Transparent Bantu Languages by Teacher Trainers

| | Method | Percentage (%) |
|---|---|---|
| 1. | Look and say – whole word | 63.6 |
| 2. | Phonic | 54.0 |
| 3. | Syllabic | 14.3 |
| 4. | Teaching letter names as the first step | 72. |
| 5. | Teaching of letter sounds as the second step | 68. |
| 6. | Teaching appropriate letter names as the first step to learning to read | 63.6 |
| 7. | Teacher trainers preferred letter sounds to be instructed in each lesson until all sounds are taught. | 66.7 |

*Note*. Teacher trainers could select more than one response.

Table 3. displays teacher trainers' knowledge about letter names and letter sounds. Of the teacher trainers, 72.7% agreed that letter sounds behave highly consistently in the writing of local languages, but practically no letter has the same sound everywhere in English. Additionally, 68.2% of the teacher trainers disagreed that English letter names are well known by everyone and require no attention. Just over half of the teacher trainers (54%) indicated that letter sounds are more difficult to instruct when teaching reading in English, and 77.3% claimed they instructed trainee teachers to focus on instructing children to learn the letter sounds, while 95.5% of the trainers disagreed that the basic steps of learning English and local languages are the same.

Table 3. Teacher Trainers Knowledge on Letter Names and Sounds of Alphabetic Writings

| | Statement | Respondents (%) |
|---|---|---|
| 1. | Teacher trainers agree that letter sounds behave highly consistently in writing of local languages, but practically no letter has the same sound everywhere in English | 72.7 |
| 2. | Teacher trainers disagreed that English letter names are well known by everyone and require no attention | 68.2 |
| 3. | Teacher trainers agree that letter sounds are more difficult to instruct in teaching reading in English | 54.0 |
| 4. | Teacher trainers reported that they instruct trainee teachers to focus on instructing children to learn the letter sounds | 77.3 |
| 5. | Teacher trainers disagreed that the basic steps of learning English and local languages are the same | 95.5 |

*Note*. Teacher trainers could select more than one response.

Of all the teacher trainers, 86.4% agreed that learning to read in English was much easier than in local languages, if one was able to speaks both languages while 95.5% of the teacher trainers agreed that the spoken language is especially important in learning to read in any language. Furthermore, all the teacher trainers (100%) acknowledged the importance of letter sounds in learning to read in the local languages.

When asked if the teacher trainers had completed any courses on specific learning disabilities during or after their initial professional educational training, 60% indicated they had not completed any, and 81% reported that the training courses they underwent did not contain a component of reading or literacy programme for children with special needs. In terms of time spent on teaching letter sounds, 90.9% of the teacher trainers indicated that they spent a substantial amount of time doing so and everyone's knowledge was assessed regularly during teaching. The majority (90.5%) indicated that they allocated between 11 and 30 hours to teach reading instruction at the college, and 95.5% reported that they spent between 0 and 3 hours on training basic reading skills and letter sounds.

Regarding the availability of reference books, 77.3% of the teacher trainers indicated that the availability of reference books was a significant problem. 72.7%

reported that access to computer/internet posed a slight problem. Many of the teacher trainers (59.1%) acknowledged a shortage of trained lecturers in reading as a problem and 71.4% of the teacher trainers indicated the lack of access to training in reading instructions as problematic. The majority of the teacher trainers (72.7%) reported that access to teaching and learning aids/materials was a significant problem in the colleges and 86.4% also reported to have no computer-based training or language laboratory in their colleges of education. Regarding language of instructions half (50%) of the teacher-trainers indicated that language of instruction was not a problem.

Overall, the results indicated that most of the teacher trainers (86.4%) felts that reading acquisition is easier in English, if one speaks English than in the local Bantu languages. This finding show that teacher trainers lack knowledge/information on the effects of orthograph depth on reading acquisition. The majority of the respondents (63.6%) selected Whole word approach -as their preferred approach to instructing reading in transparent writing systems. 72.7% of the teacher trainers reported teaching letter names as the first step in instructing reading in transparent writings and teaching letter sounds as the second step. The majority of the teacher trainers cited non-availability of reference books (77.3%) and teaching and learning materials (86.4%) as the most significant problems when instructing trainee teachers. Furthermore, 81% of the teacher trainers had no literacy component or programme in their initial teacher training, meaning that themselves were not well versed in literacy instructions.

### 7.1.2 Teacher background knowledge about reading instruction

The results from the teachers' background questionnaire showed that 45.8% of the teachers indicated that the current methods address the children's reading challenges relatively well and 39.4% very well, while 22.2% felt that the methods did not address the reading challenges at all. Similarly, 47% of the teachers selected the phonic method as the most appropriate method for teaching reading, followed by Whole word approach (23.6%). While the syllabic (6.94%) method was the least preferred method, 33.3% of the teachers did not have any preference. In terms of the order of focus in teaching reading in Zambian Languages, 73.6% of the teachers indicated that teaching of phonemes should be the starting point, followed by the syllables and then words.

Regarding the teachers' familiarity with letter sounds of Zambian languages, 50% of the teachers could pronounced most letter sounds and 13.9% could not pronounce all letter sounds in their native language. The results further showed that 85% of the teachers assessed the learner's knowledge of the letter sounds regularly, and 1.4% of the teachers indicated that letter sounds were not relevant when teaching basic reading skills in transparent bantu languages. In addition, 58.3% of the teachers agreed that the Bantu languages behave in a consistent manner at the grapheme–phoneme level. The majority of the teachers (61.1%) indicated that English vowel sounds are represented differently in different contexts and 45.8% agreed that few letters in English behave

consistently in all contexts. In terms of instructing Zambian local languages, 75% of the teachers consider the teaching of letter sounds as the most appropriate method for Zambian Languages while 70.8% indicated that children can invent and assemble words after learning the letter sound connections of the Bantu languages. In addition, the results also revealed that 49% of the teachers use text messages, 8.3% use email and the remaining teachers use other message forms for writing in Zambian languages outside of school. The majority of the teachers (75%) indicated that the language of training for instructing initial literacy is mainly in Zambian languages and 25% in English. Appendix 1. presents the factors that are perceived to cause low literacy levels in Zambia. The results show that 62.5% indicated lack of access to reading materials as the main obstacle of reading development in early grades, followed by a poor home environment.

Findings further showed that 54.1% of the teachers reported that time allocated to literacy instructions is insufficient, and 70% reported that they spend five hours per week on instructing literacy, while only 5.6% spent six hours per week on instructing literacy. In terms of support given to learners to help their reading, the study showed that only 4.1% of the teachers used computer-based training to help learners learn to read and the majority (68.9%) used various kind of remedial work to assist learners with reading challenges (see Table 4).

Table 4. Teachers' Support for Children Learning to Read

| Statement | Percentage |
|---|---|
| 1. Provide no support | 2.9 |
| 2. Provide individual support | 20.8 |
| 3. Provide sufficient support | 37.5 |
| 4. Provide extra work | 19.4 |
| 5. Engage reading experts | 2.8 |
| 6. Provide remedial work | 68.9 |
| 7. Computer based-training | 4.1 |

*Note*. Teachers could select more than one response.

When teachers were asked if they had ever attended post-teacher education training, 51.4% indicated that they had never attended such training. However, the majority of the teachers (94.6%) reported to have been inducted through the newly introduced national literacy framework – the PLP and 87.7% reported to have understood the new literacy framework relatively well and very well, but 13.3% were not sure if they understood the framework very well. The majority of the teachers (83.8%) indicated they had a literacy programme in their initial teacher training.

## 7.2 Study II. Assessing the Vowel Letter-Sound Knowledge of Early Grade Teachers using an experimental based measurement tool.

Table 5. present a summary of teachers' knowledge of vowel letter sounds. The results show that highest mean score of correctly marked and unmarked responses were recorded in vowel letter O (98.69) and the lowest was recorded in vowel I (65.63%), for recognition of English words containing the vowel sounds presented. This result confirms the confusion resulting from teaching letter names of English and not letter sounds in local languages, and how it affects the teachers' knowledge. The mean scores for each vowel letters are shown in Table 5 and many teachers knew most of the vowel sounds relatively well, but still many had problems at least in one or two vowel letters (less than 95% correct). The mean scores for correctly marked and unmarked for each vowel letter was 20, recorded for vowel letter I, followed by U, with 33.

Table 5. Mean, SD, Minimum and Maximum Correctly Marked and Unmarked Scores in the Pre-test Assessment

| Vowel | No. | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| A | 32 | 82.9 | 10.905 | 56 | 89 |
| E | 32 | 86.56 | 10.03 | 70 | 100 |
| I | 32 | 65.63 | 23.683 | 20 | 100 |
| O | 32 | 98.69 | 14.024 | 40 | 100 |
| U | 32 | 82.30 | 15.150 | 33 | 100 |

*Note*. Means are the proportions correctly marked and unmarked responses of the minimum or maximum possible score of the total pre-intervention assessments.

The mean score for the total pre-intervention assessment was 39.0625 (SD = 5.936) of the correctly marked and unmarked responses (see Appendix 7). The correctly marked and unmarked scores ranged between 20 and 100. Table 6. shows the mean scores of the post-intervention assessment. The highest mean percentage scores of the correctly marked and unmarked responses were recorded for vowel letter O (M = 91.88); and the lowest were for vowel letter I (M = 80). Thus, vowel letter O was the least challenging and vowel letter I was the most challenging for some teachers. Appendix 8. shows the overall mean scores of the total post-test assessment results (M = 42.375, SD = 5.45805).

Table 6 Mean, SD, Minimum and Maximum of the Correctly Marked and Unmarked Scores in the Post-intervention Assessment

| Letter | No. | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| A | 32 | 89.58 | 10.15 | 56 | 89 |
| E | 32 | 90.6 | 9.13 | 70 | 100 |
| I | 32 | 80.00 | 23.55 | 20 | 100 |
| O | 32 | 91.88 | 12.55 | 50 | 100 |
| U | 32 | 89.58 | 12.914 | 56 | 100 |

*Note.* Means are the proportions correctly marked and unmarked scores of the minimum or maximum possible scores for the total post-intervention assessment.

Overall, the teachers' knowledge of vowel letter sounds was close to acceptable levels even though not all the teachers knew all the sounds of the vowel letters well enough to help learners. The most correctly marked and unmarked scores were recorded for vowel letter O and the least for vowel letter I. The lowest mean score in both the pre- and post-intervention assessments, was again lowest in vowel letter I. The teachers' knowledge of vowel letter sounds in the total post-intervention assessment was better than before the intervention, especially concerning the letter I, though the scores did not reach the maximum value for some of the vowel letters.

Vowel letter I was again the most challenging vowel letter in both the pre- and post-intervention assessments for most teachers which reveals the effect of the usage of English letter names when judging the sounds of vowel letters. In English, the letter I is named in a way that does not refer to the most typical sound it represents. However, it often occurs before the letter n where it is sounded as /i/ which is the correct sound for representing this letter in the Bantu languages. These findings reveal that the most difficult vowel letter sound is I.

## 7.3 Study III: Observing and Validating the Questionnaire based Vowel Letter-Sound Knowledge of Teachers Using GraphoLearn Technology

In the GL letter-sound assessment, based on letter-sound confusion data, target A did not pose a problem for the teachers as illustrated in Appendix 10. Of the 32 teachers, only one selected E, so it is considered a rare incorrect answer or random mistake such as letter K and V. Almost all (92%) of the teachers knew vowel letter A in the first letter sound assessment. Vowel letter E was selected by 75% of the teachers correctly. However, the biggest distractor for E is A: 22% of the teachers selected vowel letter A for E (see Appendix 11). In the case of vowel letter, I, 69.4% of the teachers selected it correctly in the first assessment. There is a variation in terms of responses to target I. There are five cases (13.5%) in which the teachers selected E and 3 cases (8%) of those who chose L, presumably because the letters were in lower case so l and I looked very similar. This

confusion is brought about by the teaching of English letter names instead of the letter sounds of Zambian Languages. Vowel letter I proved to be the most difficult, followed by E (see Figure 3).

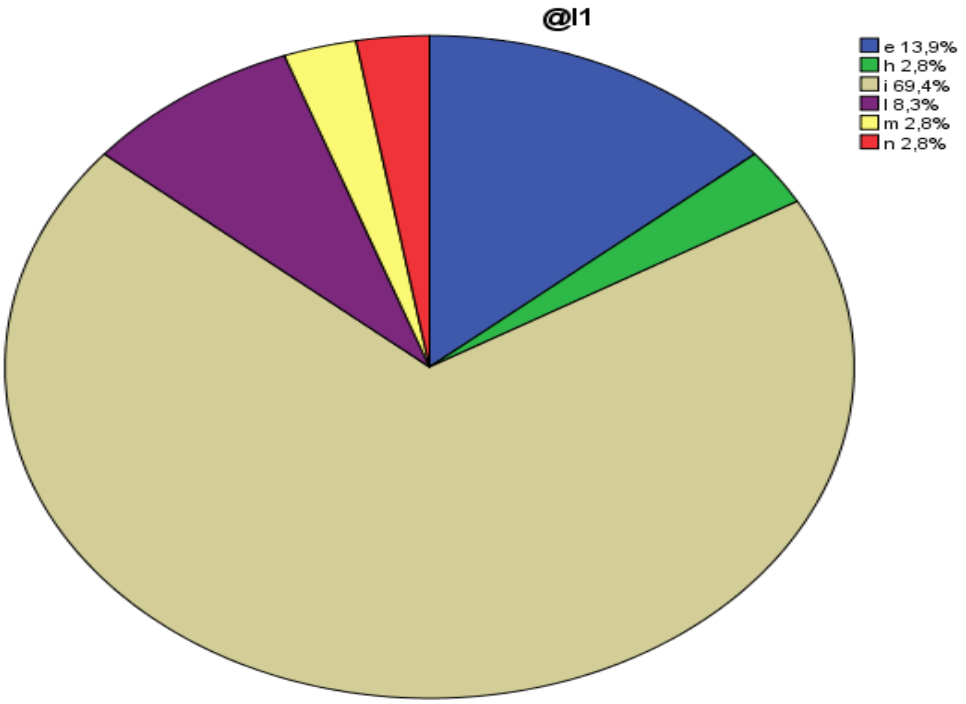


Figure 3 Teachers' responses to vowel letter I.

Of the teachers, 80.6% responded correctly to vowel letter O. However, there are also many variations with distractors. O is the first letter that is presented in the letter-sound assessment, so it is natural that there are mistakes because players might not yet know what to do, and were thus trying out the game and instead of showing their actual knowledge. In this sample, two teachers did not answer anything to O in the first assessment (see Appendix 12). Appendix 13 shows that 91.7% of teachers knew vowel letter U in the first assessment; there were a few individual cases with incorrect responses, but with no clear pattern. The main distractors are B, O and V. Table 7. summarises the total correct responses for each vowel letter by the teachers participating in the first GL assessment.

Table 7. Teachers' Correct Responses on Each Vowel Letter in the GL Assessment

| Target Letter | No. | Percentage (%) |
|---|---|---|
| A | 32 | 92 |
| E | 32 | 75 |
| I | 32 | 69.4 |
| O | 32 | 80.6 |
| U | 32 | 91.7 |

These findings suggest that I and E are the most problematic vowel letters and A, U and O are the least challenging for the teachers. Appendix 9 shows the overall pattern of the confusion matrix, which shows the target and the distractor. The darker the colour at the intersection box, the higher the frequency of mistakes. It can be observed that when E is the target, some teachers tend to pick A. Thus, teachers confuse E for A. Table 8. shows the target letter and distractors. The probability of selecting vowel letter I instead of E were 0.002, followed by E for A. This probability means that there were more chances of selecting E instead of I because of the confusion associated with the letter names in the Bantu language and the English letter sounds. The results also suggest that teachers tended to confused A and E for similar reasons to those explained. The pattern of the matrix indicated that teachers' knowledge of the vowel letter sounds is good, though many teachers still had problems with individual vowel letters such as E, I and A.

Table 8. Probability of Teachers Selecting a Wrong Vowel Letter in the GL Assessment

| Target Letter | Probability Levels | Distractor |
|---|---|---|
| A | 0.006 | E |
| E | 0.002 | I |
| I | 0.0095 | Y, L |
| O | 0.007 | W, M, L, U |
| U | 0.0035 | W |

## 7.4 Study IV: Can GraphoLearn Intervention Correct the Teachers' Compromised Vowel Letter-Sound Knowledge?

This study investigated how teachers' knowledge of vowel letter-sound is compromised and how GL interventions can help to improve their compromised knowledge. The GL results show that teachers' knowledge of vowel letter-sounds knowledge is compromised in vowel letters E and I, but is accurate in all other vowel letters. The total mean play time was 30 minutes and maximum play time attained was about 72 minutes. The initial planned play time was at least two

hours, which was sufficient for a teacher to learn the letter-sound knowledge; however, none of the teachers achieved this length of play due to practical challenges such as a lack of electricity to recharge the phones, internet connectivity and non-commitment by the teachers. Additionally, it was difficult for the teachers to overlook their knowledge of English letter names, but maybe easier to those who have not been introduced to the English letter names. The teachers' knowledge of the vowel letter sounds improved in the second assessments compared to the first assessment (see Table 9), especially in vowel letters A, E, I and U. Paired sample t-test revealed some gains (see Appendix 10), from the pre-test to the post-test in all vowel letters except [O]; t = 839, df (31), *p* = -.408.

The total mean difference (Total_Diff) between the post-test and pre-test scores was 3,3125(SD = 6,01309). The teachers correctly marked and unmarked scores were better in the post-test, suggesting that the teachers had improved. The paired sample t-test scores, t = 3,116, df = 31, *p* =.004, showed significant differences between the total pre- and post-test. (see Table 10). Based on the paired t-test, these findings inform us that teachers' knowledge of vowel letter sounds were better in the post- intervention measure compared to the pre-intervention measure. These findings confirm the researcher's hypothesis that GL supports the training of teachers' letter-sound knowledge, if used optimally. A few minutes of play can support the training of letter sounds.

Table 9. Statistical Difference between the Pre- and Post-Assessment Scores in the Study

| Variable | N | Mean | STD | df | f | P |
|---|---|---|---|---|---|---|
| A_Post & A_Pre | 32 | ,594 | 1,073 | 31 | 3,129 | .004 |
| E_Post &E_Pre | 32 | ,406 | 1,043 | 31 | 2,204 | .035 |
| I_ Post & I_Pre | 32 | 1,438 | 2,313 | 31 | 2,271 | .001 |
| O_Post & O_Pre | 32 | ,219 | 1,475 | 31 | 839 | .408 |
| U_Post &U_Pre | 32 | ,656 | 1,537 | 31 | 2,416 | .002 |

Overall, statistical differences between the two measures showed that t teachers' knowledge on vowel letter sounds improved in the second assessment. This was after teachers trained with GL, suggesting that the improved teacher vowel letter sound knowledge was due to GL training even though the time needed to overcome the English letter names may be longer than expected, meaning that the teachers needed to use the game for a substantially longer period. The content of the game should perhaps also be modified to emphasise the items which are incompatible with English letter names.

# 8 DISCUSSION

## 8.1 Teacher trainers and teachers background information and subject knowledge about reading instruction of transparent Zambian Bantu languages.

Study I investigated the teacher trainers and teachers background information and subject knowledge about reading instructions of transparently written Zambian Bantu languages. The findings from study I. reveal gaps in the background knowledge of teacher trainers and teachers on reading instruction in transparent writings. The majority of the teacher trainers and teachers were not adequately informed about literacy concepts and approaches of alphabetic writing systems, especially transparent bantu languages. This finding confirms the study hypothesis that teacher trainers and teachers may lack adequate background knowledge in matters related to instructing reading effectively in transparent local languages. This result is unsurprising, especially for teacher trainers, because their initial training did not contain a reading programme or did not receive sufficient training in literacy instructions of the Bantu languages, as the study confirmed. Studies have shown that educators lacking background knowledge in reading instructions cannot instruct reading to learners effectively (Al- Hazza, 2009; Bink-Cantrell 2012; Joshi et al 2009; Moats & Foorman, 2003 Spear-Swerling, 2005). This could impact negatively on how Zambian children are being instructed to acquiring basic reading skills (Ojanen et al., 2014; Sampa et al., 2018). In addition, the majority of the teacher trainers were trained and taught in English which requires a very different method of reading instruction from that needed for instructing the Zambian Bantu languages (Aro, 2003; Lyytinen et al., 2015). As teacher trainers themselves learnt to read by first reciting letter names of the English alphabet, which method they apply when attempting to instruct teachers how to teach reading in transparent local languages.

The teacher trainers and teachers were also not sure of the most appropriate methods for instructing reading in transparent languages or English. According to Binks-Cantrell et al (2012), poor classroom instructions can cause lack of understanding of basic literacy concepts. Recent studies have recommended phonics method as the most appropriate way for instructing reading in transparent writing systems (Al-Hazza, 2009; Castle et al., 2018; Lyytinen et al., 2009). The phonics approach is also used for English, although the phonics should be applied very differently (e.g. Moats et al., 2003). As reading instructions are not universal (Abadzi, 2013; Seymour, Aro and Erskine, 2003), the differences in orthography have a profound effect on learning to read (Aro, 2005; Aro & Wimmer, 2003). In view of the above differences, orthography-specific instructional approaches have been adopted to instruct reading effectively in different writing systems. Furthermore, the descriptive statistics from Study I, revealed that the majority of the teacher trainers (72.7%) considered teaching of letter names as the first step when instructing reading in transparent Zambian languages, while 68.2% considered that letter sounds should be taught first. This finding is contrary to the previous findings (Lyytinen et. Al., 2009; McGuiness, 2014) which have singled out letter-sound knowledge as the first step in instructing reading in transparent languages. While, the majority of teacher trainers (86.4%) indicated that learning to read English was much easier than the local languages that are opaque contrary to (Aro, 2005; Aro & Wimmer, 2003; Lyytinen et al. 2009; Seymour, Aro and Erskine, 2003). For example, in a longitudinal study of European languages, it was found that children learning to read English spend 2 to 3 times more time than do children learning in Finnish /German or the Bantu languages (Aro & Wimmer, 2003; Seymour, Aro and Erskine, 2003, 2003). These findings show that the teacher trainers lack an understanding of the effects of orthographic differences on literacy acquisition.

Findings from this study also show that most teachers seldom use written materials in the local Zambian languages outside of school and that very few use email or text messages to communicate in local languages despite being familiar with the local languages (Kashoki, 1990). As shown in (Chapters 1.2), local languages were accorded a lower status in Zambian society soon after independence when everything was to be centred on English, which is shown for example in the lack of newspapers and children's reading books written in the local languages. This situation had a significant impact because no one is able to learn to read without reading a lot (Folotiya-Jere et al., 2014; Lyytinen al., 2009;).

Furthermore, the findings revealed that very few teacher trainers and teachers use computer-based technology to instruct reading in the colleges of education and in the schools. A lack of access to computer-based support in instructing reading has been cited as problematic by both teacher trainers and teachers; this lack of access is unsurprising because CAIs are only just emerging in Zambia, and most colleges of education and schools are still poorly resourced and under-equipped and coupled with, most teacher trainers and teachers are not trained in the use of CIA-based tools to facilitate reading instruction effectively. The study also showed that most colleges of education and schools

lacked access to reading materials (72.7%). Teacher trainers (77.3%) reported shortage of reference books as a challenge. This is also unsurprising because, currently, funding to the MoGE is inadequate and erratic. In 2019, the Government allocated less than 4% of the country's GDP and less than 16% of the national budget (GRZ, 2019) towards general education. The primary education is the most heavily affected sector. The study also revealed that time allocated for reading instruction in both colleges of education and primary schools is inadequate because of a shortage of classroom space, which has resulted in learners having to share classrooms in sessions to accommodate eligible learners, so that no one is left behind.

In terms of the teachers' background knowledge about reading instructions, the study revealed that they lacked adequate background knowledge and information on how to best instruct reading in local transparent languages. 47% of teachers preferred phonic method for instructing reading in transparent Zambian languages. Snow, Burns and Griffin (1998) recommended effective instructions as remedy to preventing reading challenges among children in early grades. If teachers do not understand concepts about knowledge about reading, they will fail to provide corrective feedback, and learners will continue making the same errors (Bink-Cantrell et al 2012; Snow, Burns and Griffin (1998)). These findings were surprising because the descriptive statistics indicate that the majority of the teachers (83.8%) in the study had a component of literacy in their training and were thus expected to be knowledgeable in the subject matter. Furthermore, 94.6% of the teachers admitted to have been inducted through the newly introduced literacy framework – the PLP, and the majority (87.7%) indicated that they understood the new literacy programme well. The PLP was introduced to teach reading in local familiar languages using a phonic approach, starting by teaching the letter sounds, before proceeding to bigger segments.

Overall, the findings suggest that some teacher trainers and teachers are not adequately informed about reading instructions. A lot of gaps have been identified in this study. This lack of background knowledge is attributed to the historical background related to how they were taught to read in school as discussed earlier. And also show that colleges of education are not providing necessary information and content on reading instructions (Binks-Cantrell et al., 2012; Joshi et al., 2009; Sweet, 2004). These findings confirm the study's hypothesis that most teacher trainers and teachers lack adequate background/or subject knowledge to effectively instruct the reading of local Zambian languages.

## 8.2 Assessing the Vowel Letter Sounds Knowledge of Early Grade teacher using An Experimental Questionnaire Based Measurement Tool.

The second study investigated the vowel letter-sound knowledge of early grade teachers using an experimental measurement tool that was specifically

developed to find out the ways in which ways their knowledge is compromised. The measurement was administered twice to the teachers (pre- and post-intervention). The findings revealed that some of the teachers' knowledge of the vowel letter sounds was compromised because they failed to attain the maximum value of correctly marked and unmarked responses in some of the vowel letters. The vowel letter I in both assessments had the lowest mean among the correctly marked and unmarked scores.

These findings show that while most of the teachers' knowledge of vowel letter sounds was good in both assessments, many of the teachers did not know all the vowel sounds, which is a concern because teachers need to know the correct answers to help correct the learners' mistakes and instruct learners' reading effectively. This finding confirms the study's hypothesis that some early grade teachers' knowledge of vowel letter sounds is compromised. These results were expected because previous studies referred to the influence of the sound associated with the names given to English letters. However, if we take into account that the special PLP teacher training programme was introduced in Zambia in 2013 which emphasised a phonic approach to teaching early reading skills, these results are not as good as expected, thus indicating that the programme failed to achieve its goal. This outcome is understandable because the sounds are difficult to learn without having the opportunity to explicitly listen to how they are sounded. Models of the sound may be needed via a sound output such as that provided by GL.

Previous studies in Zambia (Folotiya et al., 2014; Lyytinen et al., 2015; Ojanen et al., 2014) have shown that the challenges in instructing reading that are experienced by Zambian teachers can be partly attributed to teachers using names assigned to the English letters instead of teaching the letter sounds of Zambian Bantu languages. The teachers' knowledge of the Zambian Bantu languages letter sound was thus interpreted to be compromised based on the learners' proficiency in reading, without explicitly assessing the teachers.

This study also found that some teachers' knowledge of the vowel letter I was highly compromised before and after the intervention. This result can be explained by the confusion attributed to English letter names and the Bantu language letter sounds, as previously explained. Many teachers use the letter names of English when they teach because they use the same methods, as when they learnt to read in English at school themselves. It also appears to be a general habit in Zambia to use the names given in English for letters when they occur in Zambian languages, even though the correct names should be the same as their sounds, with the difference associated with lengthening only (e.g. A=(/aa/). However, whether this knowledge of letter sounds achieved by most of teachers in this study alone, is sufficient to scaffold learners' reading skills is a matter for further examination because it is difficult to quantify exactly how much letter-sound knowledge teachers needed to possess to instruct reading efficiently (McCutchen et al., 2002; Moat & Foorman, 2003). However, a defendable position is that just one incorrectly sounded vowel letter could compromises the opportunity to decode words accurately due to the frequency at which the vowel

letters are used. Currently, there are no benchmarks to determine how much knowledge a teacher trainer and teacher should possess to scaffold reading skills in learners efficiently and effectively. In Finland, however, all sounds have to be reliably known and are mediated with frequent repetition for children during the first stage of their reading acquisition.

These findings inform us that while, overall, teacher's knowledge of the letter sounds was almost satisfactory in the majority of the vowel letters, there are many also whose knowledge of letter sound was found to be compromised, especially for vowel letters I and A. Naturally, the teaching success necessitates that the sounds of all letters are reliably known because even instructing only one sound erroneously can affect the children's ability to decode words accurately.

## 8.3 Observing and Validating the Questionnaire-Based Letter-Sound Assessment using GL Technology

Study III, investigated how GL can be used to observe in which ways vowel letter sound knowledge of teachers is compromised and how it can used to validate the results of earlier vowel letter sound assessment (in study II). The results confirm that GL can be used to observe the ways in which the teachers' knowledge of the letter sounds was compromised. The descriptive statistics show the mean scores of teachers in the GL assessment as; A = 92%, E = 75%, I = 69.4%, O = 80.6% and U = 91.7%. Based on the general way of interpreting the game logs, a 20% performance is equivalent to guessing and performance at 80% and above is considered to indicate real knowledge. This means that the teachers' knowledge of vowel letters A, O and U, is good. However, the results also show that vowel letters E (75%) and I (69.4%) are problematic for the teachers, which is unacceptable for a teacher that is responsible for teaching the letters to learners, as they may fail to help learners overcome the challenges of the language. The results also show that some teachers (22%) confuse the vowel letter A for E. This confusion relates to the teaching of letter names of English instead of the letter sounds of the Zambian languages; many teachers do so because of the way they received their instruction of English when they were at school.

Table 8. shows the confusion matrix for each vowel letter based on the teachers' responses. Vowel letter I had more variations in terms of responses; there were five cases (13.5%) in which distractor E was chosen and three cases (8%) in which L was chosen, presumably because the letters looked very similar to each other in lower case. This confusion relates to the teaching of letter names as opposed to the letter sounds as explained in Study II (Chapter 4.9), which most Zambian teachers learnt when learning to read themselves. These findings suggest that some teachers' knowledge of letter sounds was compromised (e.g. for vowel letters E and I).

## 8.4 Can GraphoLearn Technology Intervention Correct the Compromised Letter sound knowledge of the Early Grade Teachers?

This study aimed to find out if GL support training improves teacher knowledge of vowel letter sound correspondences. The findings from this study suggest that GL can support training of teachers' vowel letter-sound knowledge, thus confirming the study hypothesis. This study further supports findings from previous studies that learners and teachers benefitted from GL (Jere-Folotiya et al., 2014; Lyytinen et al., 2019; Ojanen et al., 2015;). The paired t-test measure (t = 3, 116(df) = 31, $p$ = .004) showed a significant improvement in teachers' correctly marked and unmarked responses from the total pre-test measure compared to the total post-test. The total pre-test means of correctly marked and correctly unmarked scores increased to 42.375 from 39.063, indicating a mean score difference of 3,3125 (SD = 6,01309). For the individual vowel letter sounds, the findings reveal that vowel letter I had the lowest mean percentage in both the pre-test (M = 65.6%) and post-test (M = 80.0%), although an improvement was recorded in the post-test. The explanation could be that the letter I had more than one correct option compared to other vowel letters that had only one correct option.

Overall, the teachers' responses improved for all vowel letters between the pre- and post-tests. According to Washburn, Mulcany, Musante and Joshi (2017), teachers need to have accurate knowledge about reading to help learners. Shanahan, (2005) has cautioned users of new technology and computers to scrutinise it carefully before introducing it in classroom for literacy development. Computer-based instructions may have potential, but they have to be scientifically validated before being used, especially with young learners. Singleton (2009) asserted that computers, in addition to classroom instruction computers can enhances motivation, though its impact can vary from one situation to another. Lyytinen et al., 2019 and Slavin et al., (2008) however, advise that computer-based learning alone can be ineffective unless combined with other methods.

The findings from Study IV show that teachers' vowel letter-sound knowledge improved in the post-intervention assessment, after training with GL, compared to the pre-test assessment in all vowel letters except one. This finding supports the results from previous GL studies conducted on learners and teachers (Jere-Folotiya et al., 2014; Lyytinen et al., 2009; Lyytinen, 2015; Ojanen, 2015;). The findings also suggest that there was an improvement at the individual vowel letter level, except for vowel letter O, which could be because the teachers already knew this vowel letter sound. The teachers might have given correct answers in many assessments and then failed some in the process of playing the game. Based on GL data the percentage of correct responses to the vowel letter-sound assessment is the most reliable way of showing whether the teachers know

the vowel letter sounds or not. These findings suggest that GL can be used to support the training of teachers' vowel letter-sound knowledge.

# 9 GENERAL DISCUSSION

A lack of subject knowledge in reading instruction among teacher trainers affects how teachers are trained and taught, which in turn impacts their classroom instructions (Joshi et al., 2009; Binks-Cantrell et al., 2012), and eventually leads to children failing to read. This situation means teachers are not being instructed to teach reading using appropriate methods, may be because their trainers are inadequately prepared (Sweet, 2004; Walsh, Glaser and Wilcox, 2006)). These findings are historically linked to the post- independence era language policy when the medium of instruction has been English in Zambia. Most of the teacher trainers were trained and taught in English, and today's teachers also learned to read English at school age. These experiences naturally affect the current reading acquisition and instructions. Furthermore, proponents of the introduction of English as medium of instruction soon after independence (MOE, 1971) argued that English could be learnt easily because of the availability of written materials in the language and because it was a language of technology and knowledge (Kashoki, 1971; MOE, 1971). However, findings from previous studies showed variations in the rate of reading acquisition from one language to the other depending on the consistence of a language (Aro & Wimmer, 2003; Holopainen, 2002; Lyytinen et al. 2009; McGuiness, 2005) and English is not the easiest language to learn to read because in most cases it is inconsistent (Aro & Wimmer, 2003).

The government can ensure that the teacher trainers and teachers are well grounded in the background knowledge on reading related matters. This can be achieved by revising and updating the teacher training curriculum to include new content knowledge based on available evidence of appropriate reading instruction associated with the orthographic depth of each language. English methods can no longer be used as models for instructing reading in all languages, especially that scientific evidence is now available that shows challenges associated with use of English (Aro and Wimmer, 2003; Lyytinen et al., 2019), one of the most inconsistence languages. These findings further inform us that many teacher trainers and teachers lacked information on new pedagogical and content knowledge resulting from new scientific evidence that support continuous

professional development (CPD)focusing on literacy instruction. MoGE can benefit from the GL which has been installed with e-learning materials by CAPOLSA to promote the self-education of teachers and teacher trainers.

Teachers' knowledge of vowel letter sounds is critical in instructing reading as shown by the highly compromised results for reading acquisition among Zambian children in the recent EGRA results (Lyytinen et al., 2019; Sampa et al., 2018). It is concerning to discover that most teachers have gaps in their core knowledge of at least one of the vowel letters sounds. This has serious implications when such teachers are given the responsibility to instruct learners because they cannot give correct models of the sounds to learners or provide accurate feedback when learners make mistakes. Knowledge without accurate and effective instruction will yield very little and can lead to a failure in reading ability among the children. However, some teachers reached satisfactory levels, which indicates that if proper training is given to support the development of phonemic awareness as the teaching of letter sounds is key to learning to read transparent writings. This can be achieved by equipping teachers with instructional methods related to instructing the Zambian Bantu languages.

Reading experts from the MoGE and Curriculum Development Centre-CDC should develop a literacy assessment tool to monitor teachers' knowledge of the letter sounds that are critical to instructing reading transparent writings. There is also a need to review the current teacher training programme and update the content of the course curriculum to include the new evidence on reading instructions and orthographic depth of different languages. Another optimal way to correct the situation is to motivate teachers who instruct reading to Zambian children to use GL (e.g. Richardson and Lyytinen, 2014; Lyytinen et al., 2019) because it gives supports the training of accurate sounds of the letters, e.g. Bantu languages.

The findings of this study showed similar patterns to those from the experimental measurement tool used in Study II, which suggests that GL can be used to observe the teachers' vowel letter-sound knowledge. However, the findings from this study are of great concern because letter-sound knowledge is pre-requisite knowledge for instructing reading in local transparent languages; thus, if teachers responsible are unable to decode some the letter sound it would be difficult for them to help the learners learn correctly(Washburn, Mulcany, Musante and Joshi, 2017; Joshi et al .,2009; Lyytinen et al., 2015; Lyytinen et al., 2019; Ojanen et al., 2015). The fact that some teachers responded incorrectly to some of the vowel letters is an indication of the challenges they may face in scaffolding reading in children and could thus lead to learners failing to read. These findings highlight the knowledge gap related to reading instructions, which needs urgent to be addressed urgently; failure to do so will lead to high illiteracy levels in Zambia which will can impact negatively on reading development and learning achievements in general.

The government can to put in place continuing professional development programmes to upgrade the skills of teachers, who are already in service, and review the initial teacher training curriculum to incorporate more content

knowledge related to reading instructions of transparent writings. The government should also work with reading experts to implement computer-based training programmes (Lyytinen et al., 2009; Slavin et al., 2008), such as GL, that will help our teachers improve their knowledge of the letter sounds. A procurement system can also be put in place to purchase GL. More importantly, GL can be used to assess learners and newly trained teacher's grapheme–phoneme knowledge to determine their preparedness for reading and instructing reading in early grades.

The use of GL as already shown in earlier studies (e.g. Lyytinen, 2015; Lyytinen et al., 2009; Ojanen et al., 2015; Saine et al., 2010) can be used to support training of letter sounds correspondences. The findings of this study further support earlier findings and the researchers' hypothesis that playing GL supports the training of teachers' letter-sound knowledge. One important characteristic of GL is to drill a learner to repeatedly practice the letter-sound connections. The GL provides systematic opportunity for those who have reading challenges to acquire basic letter–sound correspondences in any enjoyable and relaxed environment. The differences between pre-test and post-test scores were significant, indicating that if properly administered and given sufficient time, GL can help in supporting the development of teachers' vowel letter-sound knowledge. The use of computer or smartphones to support reading instructions facilitates and reinforces classroom instructions.

In addition, researchers and teacher educators in the MoGE can use GL to assess and monitor the development of teacher knowledge if the computers or phones are connected to internet. Using GL for online training will enhance teachers' knowledge at a reduced cost because teachers can practice in their own time at their own work station (Lyytinen et al., 2019). The government can support self-learning by making available such tools as smart phones, tablets or computers, and cheaper internet to both the teacher and learners, by making them affordable and easily accessible. The pre-service teacher training programmes should be revised so that new graduates are well versed in reading instruction using computer-based technology to learn how to instruct reading. This knowledge helps the teacher scaffold reading skills in the learners and ensures that the technology is not used as a replacement for teachers. It is therefore important that teachers are conversant with the grapheme–phoneme correspondences (Ehri, 1998; McGuiness, 2014) and other smaller components or units that form a word or words.

# 10 CONCLUSIONS

This section, discusses the findings, limitations and recommendations of the dissertation and how the findings can contribute to improving literacy instructions in early grades. The goals of this dissertation were to investigate the ways in which teachers' knowledge of vowel letter sounds is compromised using an experimental measurement tool, and how a mobile-based GL intervention can support the training of letter-sound knowledge among teachers. The intention is to help improve reading instruction in Zambia's transparent local languages in the early grades. Study I investigated teacher trainers' and teachers' background knowledge about reading instruction in a transparent local language – CiNyanja. The second study investigated the ways in which teachers' knowledge of letter sounds was compromised using a measurement tool. Study III assessed whether GL can be used to assess and validate the letter-sound knowledge of teachers and to compare the results with those of the measurement tool assessments. And the last study sought to find out if GL training helps to improve letter-sound knowledge of teachers.

The overall findings from this study are as follows:

i. Most teacher trainers and teachers lacked adequate background knowledge for instructing reading in transparent local Bantu languages.
ii. Based on the results from the three assessments many teachers did not know all the sounds of all vowel letters (measurement tool– questionnaire and pre- and post-tests) and GL assessments.
iii. Teachers' knowledge on vowel letters sounds was mostly compromised mostly in vowel letter E and I in GL assessment and in vowel letter I in all the assessments.
iv. GL logs can be used to observe teachers' knowledge of vowel letter sounds.
v. Teachers knowledge of vowel letter sounds improved in almost all vowel letters after GL training support.

vi. The majority of the teacher had never received training in a literacy instruction in their initial training to teacher children in early grades.
vii. The major hindrance to effective instruction of literacy in most colleges of education and schools are teaching and learning materials (TLM)
viii. Most schools lacked computers to support CAI.

The reading level among Zambian school children has failed to reach grade level despite massive investment by the government over the past years (Lyytinen et al 2019). The Government of Zambia (GRZ) has made a number of attempts to reverse the situation but to no avail (see chapter 1). The present study provides new data on teacher trainers and early grade teachers' background knowledge of reading instructions and their core knowledge of letter sounds for instructing transparently written Zambian local language. This study advances our knowledge on what teachers know and do not know about reading instruction of transparent Zambian local languages. The knowledge of vowel letter sounds is critical when it comes to instructing reading in transparent writings. Using a measurement tool and GL, this study has shown that some teachers' knowledge of vowel letter sounds is not perfectly well for all vowel letters, which is not a good sign but can be improved by providing GL support (Folotiya-Jere et al 2015; Lyytinen et al 2019; Ojanen et al 2015).

This means that some children are being taught to read by teachers who themselves have not mastered the letter-sound correspondences sufficiently enough to help correct learners' mistakes, which can lead to children failing to read (Joshi et al., 2009; Lyytinen et al., 2019; Spear-Swerling, 2005; McGuiness, 2005; Washburn, Mulcany, Musante and Joshi, 2017)). Previous studies (Jere-Folotiya et al., 2014; Lyytinen et al., 2009; Lyytinen et al., 2019;) have shown that learners of transparent languages learn to read easily and quickly once they have mastered the letter-sound connections. Teachers must also know the order of instructing reading in transparent writing because the use of English models is not be applicable for all languages; English methods are not universal. Teaching reading of transparent writing should begin with teaching the letter sounds, before proceeding to large units of language such as syllables and words. The experimental measurement tool and GL assessments established teacher's knowledge of letter sounds correspondences was not perfectly well in vowels. Vowel letters E and I were the most challenging to many teachers. This confusion can be attributed to teaching the letter names instead of the letter sounds of the Bantu vowel letters, which many teachers learnt during childhood.

Other findings from this study affecting the effective instruction of local languages, as highlighted by both teacher trainers and teachers, include inappropriate instructional methods, insufficient instructional time, lack of access to teaching and learning materials, non-availability of computer-based training and absence of training in reading instructions. These findings are important because policymakers, teacher trainers and teachers will use this

information to design a new literacy framework that is anchored on the core knowledge of letter sounds, which will help learners in early grades acquire basic reading skills more easily. A knowledgeable teacher aided by effective classroom instructional strategies especially in the early grades, can help ameliorate potential reading and writing challenges learners, if identified early enough, e.g. in early grades or pre-school. Recent scientific studies have also documented that education-based technology-based instructions (CAI) support literacy instructions and acquisition and help learners towards reading success.

## 10.1 Limitations

This research was conducted partly in Lusaka, a pre-urban area, and partly in Eastern Province, a rural area. This setting means that the schools in rural areas were far apart, making it difficult for assistant researchers to traverse from one school to another. This setting also contributed to the limited the sample size, so that only schools within a reachable distance were included. In addition, the number of devices available for this study was limited because another group of researchers in the same project were using them to investigate GL in relation to parental/family support. In terms of sample size, only data for teachers who participated in all the assessments were analysed, which contributed to the reduced sample size. This small sample size (N = 32) could have limited the statistical power to establish reliable relationships among the variables. With a larger sample, stronger relationships may have appeared which may have defined the results differently in all four of the studies undertaken.

In Study I, some tasks had no clear instructions, some questions where repeated and but rephrased differently and, in some cases, respondents were asked to select more than one option. These issues made it difficult for the respondents and some ended up skipping some tasks, which could have affected the outcome of the findings. In some cases, more than one option was given for the answers which could have forced some to guess the answers. More challenging was that the options were in English, which could have influenced the teachers' responses negatively or positively depending on the variety of English they used.

In Study II, as there were no standard questionnaire or measurement tools already available to measure the teachers' letter-sound knowledge, the researcher had to design one. First, the task items were in English. English has different spoken dialects and some teachers could have been influenced to select a word containing a sound as it is perceived in their preferred dialect. E.g. American or British English. This variation could also have influenced the outcome. However, the researcher attempted to address this by maintaining standard Oxford English as is used in the Zambian school curriculum. Some tasks also had more than one correct response which could have influenced the results

because the probability of selecting the correct option is higher when there is more than one correct option available.

In Studies III and IV, limited time could have influenced the outcome of the GL results. Owing to the limited time available for data collection, the teacher's exposure time to GL was brief for most teachers, especially for the Lusaka-based teachers, who had only two days during a training workshop organised by CALPOSA at the University of Zambia. The teachers worked under some kind of supervision, and yet the GL should be played in a relaxed and enjoyable atmosphere. The teachers may not have been motivated to play independently in an artificial workshop environment.

Furthermore, teachers in Eastern Province relied on self-supervision, and the devices were left with them. A specific consequence is that there is no assurance about other factors the teachers might have been exposed to, and other people could have had access to the devices between the pre- and the post-tests. As is often the case with repeated interventions, it is difficult to control for the unexpected factors. For instance, the teachers could have been engaged in other activities within or outside the schools in between the two assessments could have impacted or influenced their performance.

## 10.2 Recommendations

Based on these findings, the researcher recommends that teaching in early grades should focus on building the core knowledge of letter-sound relationships, to ensure effective instruction of local transparent Zambian languages. Therefore, the current literacy framework must be revised and practical changes should be made to pedagogical techniques so that literacy instruction focuses on developing phonemic awareness, which is attainable through systematic instruction of grapheme–phoneme correspondences before proceeding to larger segments such as words, phrases and sentences. Development of phonemic awareness and reading performance develops reciprocally in highly transparent writings in early grades (Lerkkanen, 2003).

The MoGE should also incorporate new computer-based technology, such as the Finnish developed digital-based learning environment (GL) in the school literacy framework and teacher training curriculum to support teacher training in the core knowledge of reading instruction. Recent studies conducted in Lusaka suggest that when, both the teachers and their learners played GL the best results of letter-sound knowledge were recorded (Folotiya-Jere et al., 2014). To ensure quality instruction of reading, the MoGE should subject early grade teachers to a licentiate examination to qualify to instruct reading. This assessment can be done successfully via GL, which was tested in sub-studies III and IV of this study to observe and assess teachers' knowledge of letter sounds and determine in which ways their knowledge is compromised. All prospective teachers of early grades must pass this examination to show their competence on sounds of the letters

and fluency in the regional Bantu local languages (lingual fracas) of their respective regions to qualify to teach. This qualification can be used as a criterion for teacher registration with the Teaching Council of Zambia (a teacher professional body that regulates the professional conduct of teachers) and for an individual to be recruited to teach literacy in both public and private schools in Zambia. Recently, the MoGE issued a policy direction instructing education officials in schools, districts and regions to introduce subject specialisation in primary schools to promote quality teaching. GL fits well under this policy direction and can be used by literacy teachers to support learning of reading and to improve literacy levels in Zambia.

To serve teachers and teacher trainers, the MoGE could also develop a new in-service training programme focused on reading instruction based on GL online learning to support the training of letter-sound knowledge. The MoGE should also establish language laboratories in teacher resource centres and colleges of education installed with GL platforms to promote online training. To continue improving learners' and teachers' performance in literacy acquisition and literacy instructions, GL can be used as an assessment, monitoring and training tool. To do so, the Government should seek financing for inexpensive phones and computers on which GL can be installed to benefit even those in hard to reach areas around the country. Currently, experts from CAPOLSA, based at the University of Zambia in collaboration with the University of Jyvaskyla, are developing reading materials in the Zambian regional languages to support literacy acquisition in the sub-region.

To increase the reliability of the findings, future studies could include a teacher control group to compare the effects empirically. In addition, teachers' knowledge levels could be investigated in relation to learning outcomes to establish how they translate to learners' achievement in reading. The questionnaire could also be translated so that the study could be extended to the other six regional languages used for teaching initial literacy in Zambia. In addition, the questionnaire test items should be revised to include tasks in local languages to ascertain their validity. As explained in the limitations section, there is also a need to provide a uniform number of correct options for each task to avoid skewing the results. The measurement tool should also be standardised for future use and for a better understanding of teachers' knowledge levels, both in terms of subject/content and pedagogy in reading literacy, and attitudes towards the reading instruction of local transparent writings.

## SUMMARY (ENGLISH)

This research is a response to challenges Zambian early grade teachers are experiencing in providing quality instruction to help learners acquire basic reading skills. The study consists of four sub-studies. The first study examined the teacher trainers' and teachers' background knowledge related to reading instructions. The second study investigated the ways in which the teachers' knowledge of vowel letter sounds was compromised using a measurement tool. The third study investigated how GL observed the ways in which the teachers' knowledge of vowel letter sounds is compromised and validate the same knowledge with results from study II, and the fourth study investigated whether GL can support the training of vowel letter-sound knowledge of teachers by storing the appropriate sounds of the letters of the Bantu languages in Zambia.

The introduction gives a synopsis of the current reading situation in Zambia and its origins, followed by an examination of the influence of orthographic depth on learning to read. The importance of teacher trainers' and teachers' background knowledge in reading and its implications on teaching reading were then discussed. Furthermore, the study examined the instructional methods of instructing reading with a special focus on the phonics method. In addition, the education reforms and policy changes initiated by Government of the Republic of Zambia (GRZ) during the post-independence era e.g. language policy and its implication on teaching reading were discussed. The dissertation also examined the new literacy programmes introduced by the government to improve reading and discussed educational technology with a focus on how GL can support the acquisition of the core knowledge of letter sounds that are key to learning to read transparent writings.

The participants were 22 teacher trainers (Females=5, Males=17), with a mean age of 44.569 years (SD = 5.49) and an average of 2.29 years (SD = 1.06) working experience in teacher education. The teachers 32(Females=22, Males=10) with an average age of 34.19years (SD = 5,78). They had an average teaching experience of 7.56 years (SD = 6,61). The teachers were drawn from schools in Lusaka and the Eastern Provinces of Zambia.

Study I investigated the teacher trainers' and early grade teachers' needs associated with reading instructions; 72.7% of the teacher trainers viewed teaching the names of the letters as the first step of reading instruction, and 68.2% rated the teaching of sounds of letters as the second step. Of the teachers, 86.4% supported the statement that learning to read in opaque English is much easier than in a transparent local Bantu language, if one speaks both languages, and 63.6% of the teacher trainers preferred the Look and Say Method for instructing reading compared to 54.5% for the phonic method. Regarding the teachers' background knowledge, 75% viewed letter sound teaching as the most appropriate method for instructing Zambian Languages and 45.8% agreed that few letters in English behave consistently in all contexts. Of the teachers, 47% indicated the phonic method as the preferred method to use when teaching reading, 23.6% preferred the Look and Say method and 6.94% preferred the

syllabic method. The majority (73.6%) of the teachers indicated phonemes, syllables and words as the order of focus when instructing reading in Zambian. The findings show that some teacher trainers and teachers lack information on reading instruction approaches; less than half the teacher trainers selected the Look and Say method and less than half of the teachers selected the phonic method, thus indicating a gap in their knowledge.

In Study II, the teachers' knowledge of vowel letter sounds was investigated using an experimental measurement questionnaire/tool to find out in which ways their knowledge of vowel letter sounds was compromised. Participants (as in Study I) were administered the assessment questionnaires twice, before and after exposure to GL. The findings from this study show that the highest score of correctly marked and unmarked responses was recorded for vowel letter O (98.69 %) and the lowest was for vowel letter I (65.63%) at the individual vowel letter level in the pre-test. The consolidated mean scores of the total pre-test scores was 39.0625 (SD = 5.94). The findings show that not all the teachers knew all the vowel letter sounds in the pre- assessment because some had recorded incorrect responses. In the total post assessment, the highest correctly marked and unmarked responses were for vowel letter O (91.88%) and the lowest were recorded for vowel I. The mean score of the total post-test responses was 42.375 (SD = 5.49). The results show that the most challenging vowel letter is I and the least difficult vowel letter is O. Teachers' knowledge of letter sounds was relative good, although not every teacher responded correctly to all the vowel letters.

Study III investigated in which ways the teachers' knowledge of letter sounds was compromised using the GL and how also how GL can be used to this knowledge. The participants were the same as those in Studies I and II. The GL letter sound assessment revealed the following results: A = 95%, target O = 87%, target U = 81%, target E = 65% and I = 62%, indicating that targets [E] and [I] were more challenging for the teachers. Teachers letter-sound knowledge was compromised for vowel letters E and I. The results reveal that teachers' knowledge of the sounds of the vowel letters is almost perfect at the end of the GL-intervention. The difficulties observed still has been referring to English letter names e.g. the most difficult vowel letter 'I' in the study whose name is not that, although its sound /i/ is the most common sound it represents in written English.

Study IV examined the effectiveness of GL in supporting the training of teacher letter sounds knowledge. Participants' (the same as in Studies I, II and III) data were analysed using SPSS version 22. The results show significance differences between the pre- and post-test scores in all vowel letters except O; (t = 839, df (31), $p$ = 0.408). The paired t-test also show statistical differences between the total pre-test and post-test scores (t = 3,116, df = 31, $p$ = .004). The paired t-test results further show that the total mean difference (Total_Diff) of 3.313 (SD = 6.01). The results inform us that teachers' responses improved in the post-test at both individual letter level and overall, after exposure to GL.

The GL-based support is recommended because it not only assesses the letter sound knowledge but also help teachers to learn the correct sounds as it is used as dynamic assessment tool. The questionnaire method helps getting some

understanding about teacher's knowledge of letter sound but is not helping in training them anyway. This means that GL is highly preferable method to be used in Zambia for helping teacher-trainers and their teachers to learn how the key knowledge of reading instruction- letter sounds could be learnt by the children. And this is especially true if teachers agree that the children will be introduced to use GL methods as soon as it will be made available in Zambia. The findings further revealed that many teachers' knowledge of vowel letter sound correspondences was not perfectly well in all the vowel letters, e.g., vowel letter I and E were the most challenging vowel letters, and lastly. This study also shows that GL can support training of teachers' letter-sound knowledge when used optimally. Overall, the results revealed that both teacher trainers and teachers lacked sufficient knowledge and letter sound knowledge to instructing reading in transparent Zambian languages.

# YHTEENVETO (FINNISH SUMMARY)

Tämä tutkimus vastaa Sambian ala-asteen opettajien kokemiin haasteisiin, miten tarjota laadukasta opetusta lukemisen perustaitojen oppimiseksi. Tutkimus jakautuu neljään osaan. Ensimmäisessä tarkastellaan opettajien ja opettajakoulutettavien peruslukutaidon opetusta koskevaa taustatietoa. Toisessa tutkitaan, missä määrin opettajien vokaalikirjainten vastinäännetuntemus on puutteellista käyttäen sitä varten kehitettyä yksinkertaista kyselymenetelmää. Kolmannessa selvitetään, miten GraphoLearn (GL) teknologia mahdollistaa tavan observoida vokaalikirjainten äännetietämyksessä ilmeneviä puutteita ja validoi toisen tutkimuksen metodia GL:n antamiin suoriin havaintoihin verrattuna. Neljännessä havainnoidaan, miten GL voi tukea opettajien Bantukielten vokaalien kirjain-äännetietämystä Sambiassa.

Johdannossa esitetään yhteenveto nykyisestä lukemaan oppimisen tilanteesta Sambiassa ja sen taustoista. Sitä seuraa lukemaan oppimiseen liittyvän ortografian merkityksen tarkastelu. Opettajien ja opettajakoulutettavien lukemaan opetusta koskevan tiedon tärkeys ja ja sen implikaatiot opetukseen ovat seuraavat tarkastelun kohteet. Opetusmenetelmistä esitellään erityisesti fooniks-pohjainen menetelmä. Lisäksi pohditaan Sambian opetusuudistuksien ja -politiikan muutosten merkitystä itsenäistymisen jälkeisenä aikana koskien esimerkiksi kielipolitiikkaa ja sen implikaatioita lukemisen opetukseen. Tarkastelun kohteena ovat Sambian uudet lukemisen opetusta koskevat ohjelmat, joilla opetushallinto johdatteli opettajia lukutaidon parantamiseen. Seuraava esittelyn aihe on koulutusteknologia erityiskohteenaan se, miten GraphoLearn (GL) voi tukea oppimista, mikä kohdistuu lukemisen ydintietoon, kirjainten äännevasteisiin, joiden oppiminen on avainroolissa kirjain-äännetasolla johdonmukaisesti kirjoitetun kielen lukemaan oppimisessa.

Osallistujina olivat opettajakouluttajat N=22, joiden keski-ikä on 44.57 vuotta (standardipoikkeama (SD)=5.49) ja keskimääräinen opettajakoulutuskokemus 2.29 vuotta (SD=1.06). Naisia opettajakouluttajista oli 5. Opettajia oli 32, keski-ikä 34.19 (SD=5.78) vuotta, ja heidän opetuskokemuksensa kestokeskiarvo 7.56 vuotta (SD=6.61). Naisia opettajista oli 22. Opettajat edustivat Lusakaa ja Sambian Itäisiä provinsseja.

Tutkimus I kohdistui ala-asteen opettajakouluttajien ja opettajien lukemaan opetusta koskeviin tarpeisiin. Opettajakouluttajista 72.7% näki ensimmäisenä askelena lukemaan opetukseen kirjainten nimet ja 68.2% piti kirjainten vastinäänteiden oppimista toisena askelena. Opettajista 86.4% tuki väitettä, että englannin lukemaan oppiminen on paljon helpompaa kuin läpinäkyvien paikallisten bantukielten, jos oppija puhuu molempia kieliä, ja opettajakouluttajista 63.6% piti parhaimpana menetelmänä ”katso ja sano” (so. kokosana) menetelmää lukemaan opetuksessa 54.5%:n mielestä fooniks-menetelmää on paras. Opettajien lukemaan oppimista koskevan taustatiedon mukaan 75% näki kirjainten äännevasteiden opetuksen toimivampana menetelmänä opetettaessa Sambian kieliä ja 45.8% oli sitä mieltä, että harvat kirjaimet käyttäytyvät englannin kirjoituksessa johdonmukaisesti kaikissa

konteksteissaan. Opettajista 47% preferoi fooniks-menetelmää lukemaan opetuksessa, 23.6% ”katso ja sano” metodia ja 6.94% tavumenetelmää. Enemmistö (73.6%) opettajista näki parhaimmaksi opetusjärjestyksen: äänteet, tavut ja sanat, opetettaessa Sambian kielten lukemista. Havainnot osoittavat, että joillakin opettajakoulutettavilla ja opettajilla on puutteita lukemaan opetuksen perusteita koskevassa tietämyksessään; neljännes valitsi parhaaksi ”katso ja sano” metodin ja samoin vähemmän kuin puolet valitsi fooniks-menetelmän, täten ilmaisten tiedon puutteensa.

Tutkimuksessa II havainnoitiin vokaalikirjainten äännetietoisuutta kokeellisella kyselymenetelmällä sen selvittämiseksi, missä määrin tässä tietämyksessä on puutteita. Osallistujille (kuten tutkimuksessa I) esitettiin kysely ennen ja jälkeen GL menetelmän käyttöä. Tulokset osoittavat korkeimmillaan 98.7 prosenttisesti oikean vastauksen kirjaimeen, mikä oli O ja mutta I kirjain meni vain 65.6 prosenttisesti oikein mittauksessa mikä tehtiin ennen GL:n käyttöä. Keskimäärin yli kaikkien kirjainten oikeiden vastausten prosentti oli 39.1 (SD=5.9). Tulokset osoittivat, että useimpien opettajien vokaaliäänteiden tuntemus oli esitestissä jossain määrin puutteellinen. Paras pistemäärä intervention jälkeisessä osaamisessa koski O kirjainta, joka oli yli 90%sti oikein ja alin pistemäärä 80% tuli I kirjaimen äännevasteen tuntemuksesta. Opettajien osaaminen nousi lähes hyvälle tasolle harjoittelun tuloksena ja samalla osoitti selvästi sen, että havaitut vaikeudet olivat peräisin englannin kielen kirjainten nimistä.

Tutkimuksessa III tarkasteltiin opettajien kirjainäännetietoisuudessa esiintyviä ongelmia käytettäessä GL:ä virheiden observoinnissa. Samoilta tutkittavilta saatiin seuraavat kirjainkohtaiset tulokset äänteen oikeasta tuntemuksesta: A 95%, O 87%, U 81%, E=65% ja I 62%, viime mainittujen siis osoittautuessa haastavimmiksi.

Tutkimus IV selvitti sitä, miten GL:n käyttö harjoitti opettajien kirjainten vastinäänteiden tuntemusta. Kaikkien muiden paitsi O äänteen osalta (joka oli hyvä jo esimittauksessa) paraneminen oli tilastollisesti merkitsevää. Jos tilastollinen arviointi kohdistetaan kokonaisparantumisasteeseen, se oli erittäin merkitsevää (p .004). Edelleenkin I:n äänteen tuntemukseen jäi parantamisen varaa, niin vahva on englannin kirjainnimien vaikutus.

Tutkimusten tulokset osoittivat, ettei opettajien eikä heidän kouluttajiensa tietämys ollut adekvaattia tehokkaasta lukemaan opetuksesta läpinäkyvissä kielissään. Tämä ilmeni mm. siinä vokaalikirjainten äännevasteiden tietämyksessä, missä oli merkittävästi parantamisen varaa. Myönteistä oli, että suurin osa ongelmista pystyttiin korjaamaan suhteellisen lyhyellä GraphoLearn teknologiaa soveltavalla harjoittelulla. Sen käyttö opettajien äännetietämyksen arvioinnissa on suositeltavampaa kuin kyselymenetelmän, joka ei poista ongelmaa samalla tavalla kuin GL pysty tekemään riittävän pitkään käytettynä.

Suositeltava tapa opettaa sekä opettajat, heidän kouluttajansa, että lapset saamaan lukutaidon perusteita koskeva tieto on se, että GraphoGame saadaan käyttöön Sambiassa kaikille näille tahoille.

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# APPENDICES

APPENDIX 1 Teachers Responses on Hindrance to Reading Instructions

| Variable | Percentage (%) |
|---|---|
| No access to reading materials | 62.5 |
| Limited contact time between teacher and learners | 34.7 |
| Use of inappropriate instructional methods | 30.6 |
| Poor home environment | 38.9 |
| Illiterate parents/guardians | 26.4 |
| Language policy | 13.9 |

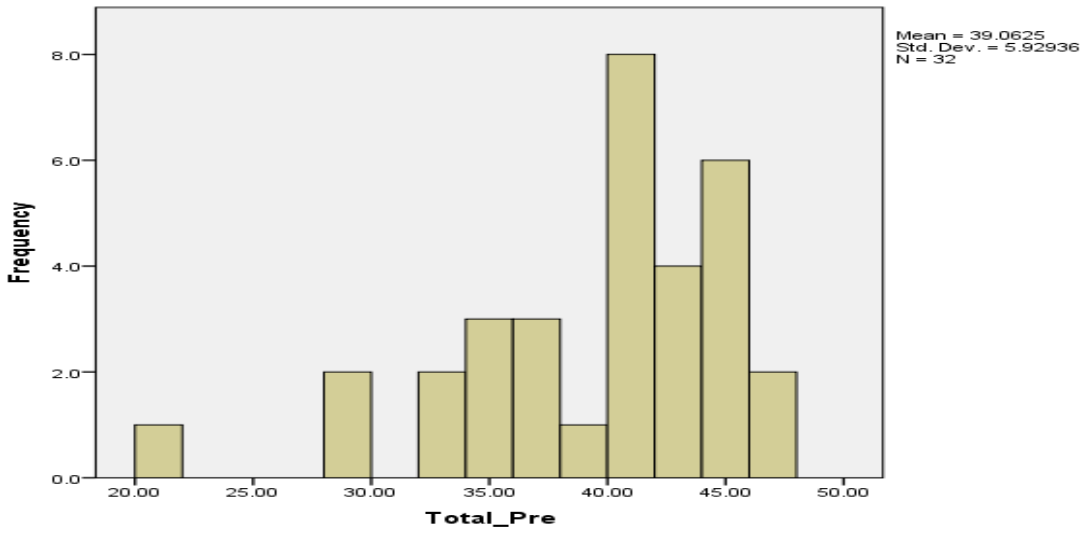
Note. Teachers could select more than one response.

APPENDIX 2 Teachers Use of Written Materials in Local Language

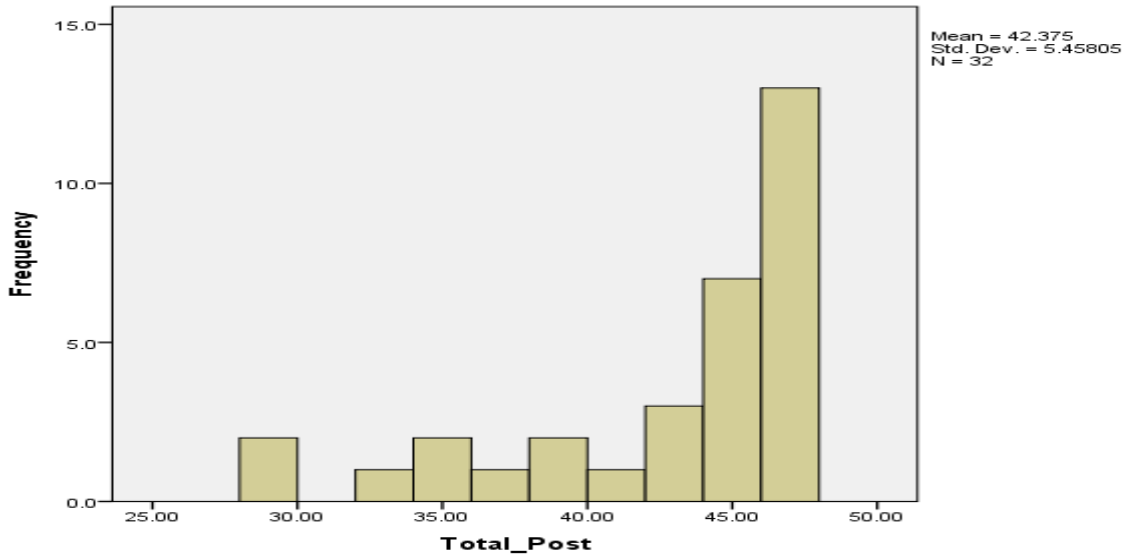
| Variable | Percentage (%) |
|---|---|
| Text messages | 49.0 |
| Notes to family members | 47.2 |
| Email or other messages | 8.3 |
| Notes in calendar, journal/dairy | 2.8 |
| Taking notes at church | 41.7 |

*Note.* Teachers could select more than one response.

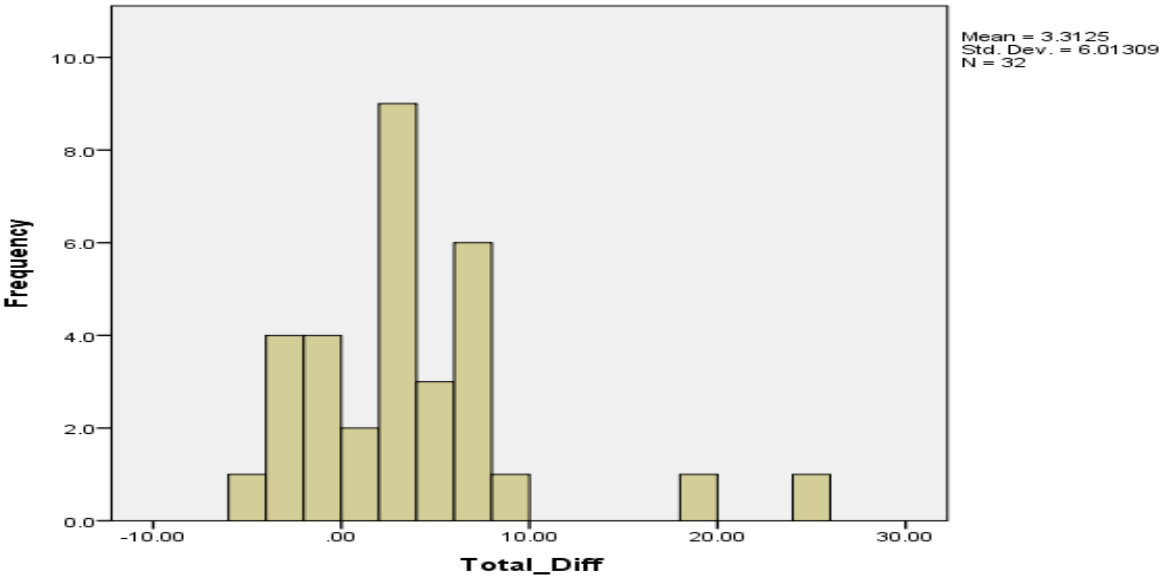
APPENDIX 3 Mean and Standard Deviation of the Total Pre-test Assessment



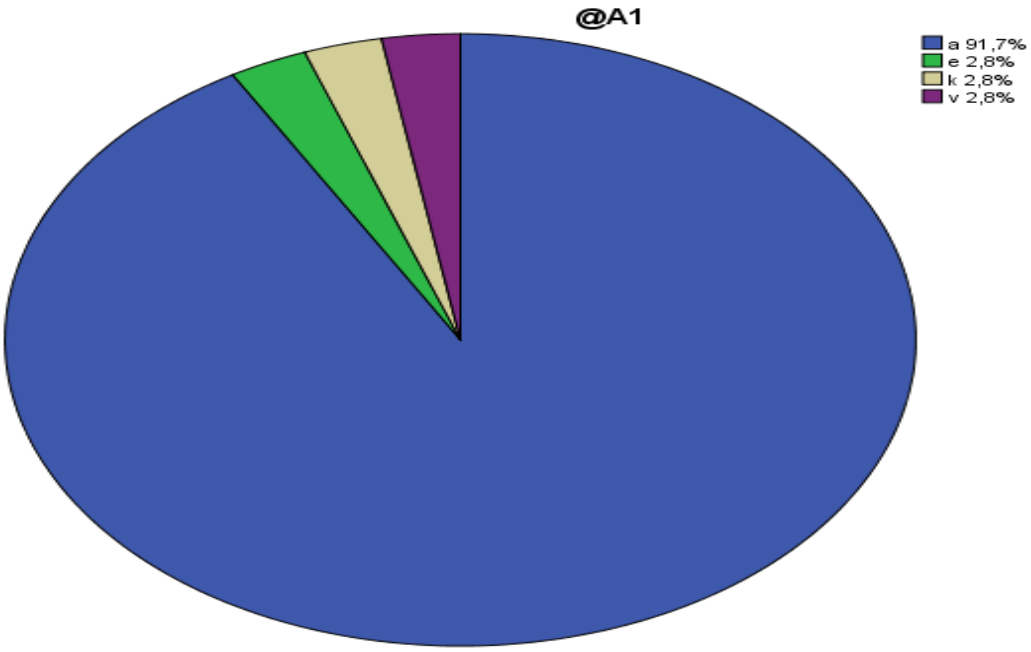

APPENDIX 4. The Mean and Standard Deviation of Post-test Assessment



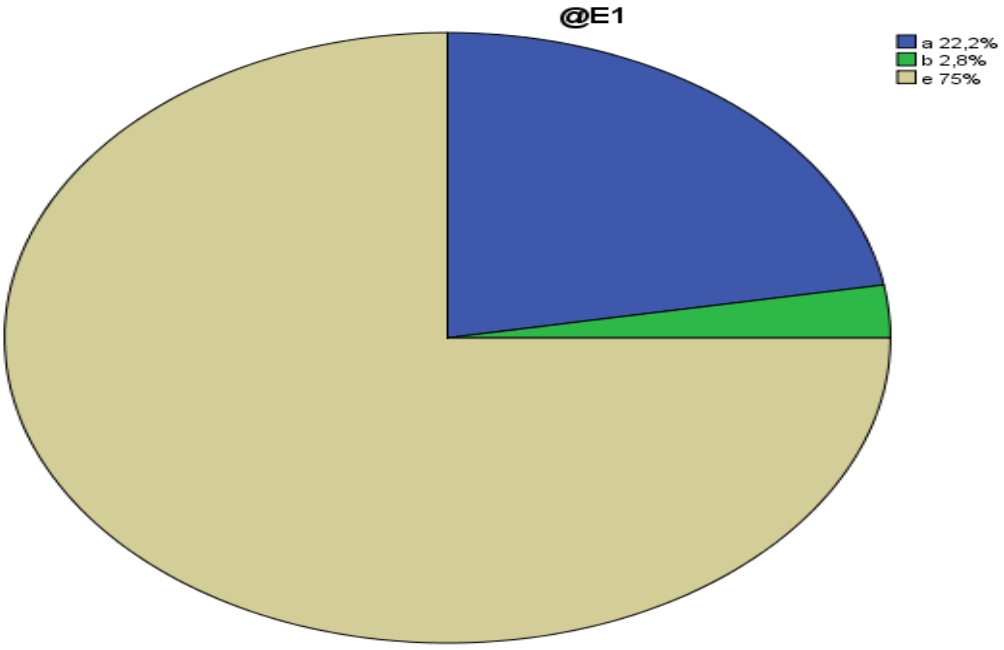
APPENDIX 5 Total Mean Differences of the Total Pre- and Post-intervention Assessment



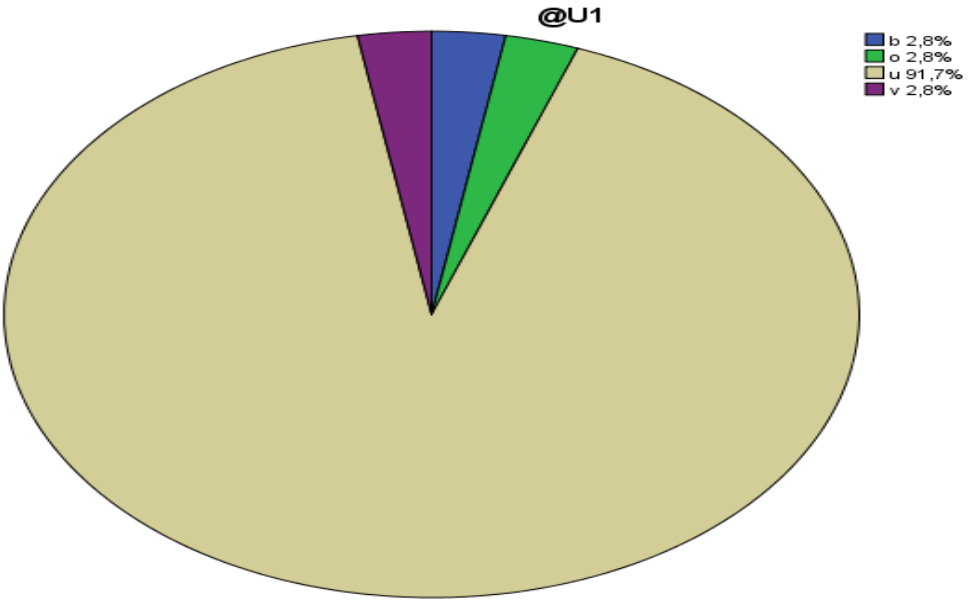

APPENDIX 6 Teachers' Responses for Vowel letter A



APPENDIX 7 Teachers' Responses for Vowel Letter E




APPENDIX 8 Teachers' Responses for Vowel Letter U



APPENDIX 9. Teacher Background Information Questionnaire

**READING INSTRUCTIONS IN ZAMBIAN SCHOOLS**

**TEACHER QUESTIONNAIRE**

This research is being conducted in selected schools in Zambia. You are one of the teachers selected to participate in the GraphoLearn training programme organised by the Universities of Zambia and Jyvaskyla of Finland. Please complete this questionnaire. Your personality or identity will not be revealed during the research process and no individual information will be reported. This data will be kept in a safe location in the University when this research process is finished. Please be truthful in answering the questions and give your personal opinion where requested.

**ID:**

**Name:**

**Province:**

**District:**

**School:**

**Contact number:**

**SECTION A:** Please tick the appropriate box or write a response.

1. What is your gender?

   1. Female ☐ 2. Male ☐

2. How old are you?

3. What is your highest academic education?
   1. Primary education ☐ 2. Junior secondary education ☐
   3. Senior secondary education ☐ 4. University education ☐

4. What is your highest teacher education qualification?

   1. Zambia Primary Teaching Certificate (ZPC) ☐
   2. Zambia Basic Education Certificate (ZBEC) ☐
   3. Zambia Teacher Education Course (ZATEC) ☐
   4. Diploma in Primary Education ☐
   5. Bachelor of Education-Primary Education ☐
   6. Others ☐

5. What was the duration of the course?

6. Have you ever attended any post college training course since you graduated?

   1. None ☐ 2. One ☐ 3. More than two courses ☐

7. Have you ever attended any Primary Reading Programme (PRP) training?

   1. Yes ☐ 2. No ☐

8. What was the duration of the training?

9. What reading programme was contained in your pre-service training?

   1. Primary reading programme ☐
   2. Early grade reading ☐
   3. English media ☐

10. What instruction methods are you using in your school to teach initial literacy in the native CiNyanja language?

11. In which native language did you receive training to enable you instruct initial literacy successfully?

    1. Chitonga ☐
    2. Kiikaonde ☐
    3. Icibemba ☐
    4. CiNyanja ☐
    5. Luvale ☐
    6. Lunda ☐
    7. Silozi ☐

12. What language do you speak mostly?
13. What language did you speak most during your childhood?
14. How much of the reading materials outside the school environment is written in the language you teach the first graders to read?
    1. Very little ☐
    2. Less than one page per typical day ☐
    3. 1-3 pages ☐
    4. More than 3 typical pages per average day ☐

15. From your experience in teaching, which language do you think children in your area can learn quickly to read and write?

1. CiNyanja ☐
2. English ☐

16. Why are children in most Zambian primary schools still reading below grade level despite the introduction of numerous reading programmes? Pick only **one** reason.

1. No access to reading materials ☐
2. Limited contact time between teachers and learners ☐
3. Use of inappropriate instructional methods ☐
4. Poor home environment ☐
5. Illiterate parents or guardians ☐
6. Language policy ☐

17. How much time is allocated to the teaching of literacy on your school timetable per week? (indicate number of hours)

18. Do you think the time allocated to teaching of reading in your school is adequate for most learners to acquire accurate reading skills before the end of first grade?

1. Yes ☐ 2. No ☐

19. How is your school helping children experiencing challenges in acquiring basic reading skills or poor readers?

1. Nothing ☐
2. Providing some individually tailored support ☐
3. Providing mostly sufficient support ☐
4. Extra lessons ☐
5. Remedial work ☐
6. Computer-based training ☐
7. Engaging reading experts ☐

20. Have you ever had any training in special educational needs?

1. Yes ☐ 2. No ☐

21. What are the current teaching methods addressing the reading problems of learners in your school like?

1. Very good ☐
2. Relatively good ☐
3. Not sure ☐
4. Not good ☐

22. Which of the following methods do you follow in your school when teaching Zambian Languages?

1. Words, syllables, phonemes ☐

2. Phonemes, syllables, words ☐
3. Syllables, words, Phoneme ☐

23. Do you have a special educational department (or at least one well trained specialist or remedial teacher) in your school that identifies and instructs learners with reading problems?

1. Yes ☐ 2. No ☐

24. How long have you been teaching?

25. How long have you been teaching the current grade/class?

**SECTION B: Important terms in reading**

26. How familiar are you with the letter sounds of any Zambian Languages?

1. I don't know because I do not need letter-related knowledge in my teaching. ☐
2. I know the letter names in used in English (/ei/,/bii/,/cii/..). ☐
3. I can pronounce most of the letter sounds. ☐
4. I know the letter names specific to the instructed writing system. ☐
5. I can pronounce all the letter sounds of my native languages. ☐
6. I can pronounce the sounds of all those local languages which are spoken among my typical pupils. ☐

27. How much attention is given to the teaching of letter-sound in your school?

1. Substantial time spent for teaching and everyone's knowledge is assessed regularly during teaching. ☐
2. Substantial time used to teach, but little assessment of mastery. ☐
3. Instructing starts from larger units (such as syllables). ☐
4. Letter sounds teaching is not needed. ☐
5. This aspect of reading instruction is much less relevant than other issues associated with the instruction of basic reading skill. ☐

Indicate 1 for true and 0 for false:

28. Bantu writing (orthographies) behaves in a consistent manner at the level of graphemes and phonemes with few exceptions. ☐

29. Only about half of the letters of written English behave consistently. ☐

30. A vowel sound in English can be represented by a number of different letters in different contexts. ☐

31. After learning the sounds of letters of a Bantu language, many children invent how a word can be assembled from the letters. ☐

32. Letter sound teaching is not appropriate in English. ☐

33. In transparent writing environments, many children learn to read before school entry if they learned the names of letters in an appropriate way. ☐

34. Letter names are not always about cuing the correct sounds represented by letters in English, which is opposite to the situation concerning local African languages. ☐

## Thank you for participating!

APPENDIX 10 Teacher Trainer Background Information Questionnaire

TEACHER TRAINER QUESTIONNAIRE

This questionnaire is intended for teacher trainers of Colleges of Education teaching Literacy and Languages to trainee primary or basic school teachers. Please provide responses that are closest to your opinion and indicate what is currently prevailing in your institution with regard to the questions or statements. Please complete all parts. The information being collected is primarily for academic purposes and will be treated with the utmost confidentiality.

### A. BACKGROUND INFORMATION

1. College:
2. Province:
3. Gender:
4. Years in service:
5. Age:

6. Indicate your teaching qualifications by ticking the box(es) (can be more than one).
   1. Certificate ☐ 2. Diploma ☐ 3. Degree ☐ 4. Master's Degree ☐
   5. Advanced certificate ☐ 6. Advanced diploma ☐

7. Experience in teacher training (years):

8. What was your initial teacher education qualification?
   1. Primary school teacher ☐ 2. Secondary school teacher ☐
   3. Pre-school teacher ☐
9. Did you receive any instruction in teacher education? 1. Yes ☐ 2. No ☐

10. If yes, how long did the training last?
    1. Less than one month ☐ 2. One to three months ☐
    3. Four to six months ☐ 4. Seven to twelve months ☐
    5. More than twelve months ☐ 6. Just inducted within the college ☐

11. Which teacher education qualification is offered at your institution?
    1. Diploma ☐ 2. Degree ☐ 3.Certificate and Diploma ☐
    4. Diploma and Degree ☐ 5. Certificate ☐

12. What are the minimum entry requirements for one to qualify for selection at your college/institution?

**B. READING INSTRUCTIONS**

Answer by ticking/or writing a number in the box(es) next to the statement(s) you consider to be the most appropriate (can be more than one).

13. What are the most appropriate first steps of reading instruction during the first term of schooling for learners learning to read a local language?
    Indicate by ticking in the box(es) next to the statement(s) you consider to be the most appropriate (can be more than one).

    1. Focus learners' attention on very easy to read written sentences. ☐
    2. Focus learners' attention on very easy to identify written words. ☐
    3. Motivate learners to attend to written language, especially letters, so that they learn to draw letters. ☐
    4. Instruct learners to learn the names of the letters. ☐
    5. Instruct learners to learn the letter sounds. ☐
    6. Instruct learners to learn to extract the sounds of the first letters of the familiar words to learn the letter sounds. ☐

14. What do you consider the order of importance during the first steps of reading instruc tion in the first grade when teaching transparent local languages in Zambia?
    Number the boxes in order of preference, e.g. 1 for the first step, 2 for the second step, 3 for the third step and so on.

    1. Motivate learners to search for the meaning of a very easy to read sentence. ☐
    2. Direct learners' attention to the reading of a written paragraph by the teacher ☐
    3. Teach the names of the letters. ☐
    4. Teach the sounds of the letters. ☐
    5. Teach how to recognise familiar words. ☐
    6. Teach how to assemble sounds together in the order of letters. ☐

7. Motivate learners to learn how to sound out letters (read orally) easily. ☐
8. Teach written words and accepting guesses. ☐

15. How do you instruct trainee teachers to teach letter sounds to first-grade pupils?

1. In each subsequent lesson until all letter sounds have been learned ☐
2. Teach a few times and/or give a few letter sounds as examples ☐
3. To be introduced to pupils as separate instructions ☐

16. Mark the order of importance of instructing your trainee teachers how they approach the small units, such as the phonemes of local languages they teach. Number the boxes in order of preference.

1. By using the English letter names to teach the sounds of the local language ☐
2. By recognising that the letter sounds of the local language differ from those cued by the letter names used in reciting alphabets of English ☐
3. By instructing the appropriate sounds of the letters of the local languageassuming that they know they differ from those of English letter names or sounds ☐
4. Using the initial sounds of familiar words of the local language to help the trainees learn to hear the sounds of each letter ☐
5. Emphasising that the first thing they have to understand is that learning the appropriate letter sounds are the key to learning to read. ☐

17. What are the most important factual differences between skills needed for learning to read in English versus a local language? Mark the statements you think are true by writing 1 for those which are true and 2 for those which are false in the boxes.

1. In principle, the basic steps of learning English and local languages are the same. ☐
2. In principle, there are related differences in how long the words are. ☐
3. Learning to read in English is much easier than in a local language if one is able to speak both well. ☐
4. Learning to know the letter sounds is important in English. ☐
5. Learning to know the letter sounds is important in local languages. ☐
6. A more appropriate learning method is the sound of larger units such as a whole word in English. ☐
7. The spoken language skill is an especially important starting point for learning to read that language. ☐
8. The number of associations between the appropriate spoken and written items one has to learn for learning to read is much higher in English than in local languages. ☐
9. One can sound out any pronounceable word of a local language after one has learnt the sounds of each letter of his language, which is not true in English. ☐
10. One English letter can represent a large number of different sounds while this not true in local languages. ☐

18. How do you instruct trainee teachers to continue teaching letter sounds to first-grade pupils? Mark those statements which you think are the most appropriate.

1. They learn to know the letter names (as used in English instructions) ☐
2. They know that there are some differences between sounds in local languages ☐ sounds in English.
3. They fully understand that there is little consistency between the ☐ letter sounds at the phoneme–grapheme level in English and the writing system of local languages.
4. A lot of emphasis is put on helping them understand how inappropriate it ☐ is to apply the knowledge associated with the names of letters used in instructing reading of English to the sounding of the phonemes represented by letters of the local languages.

19. Which of the following do you consider to be the best method for teaching letter sounds to first graders?

1. Phonic ☐ 2. Look and say (whole word approach) ☐
3. Syllabic ☐ 4. Alphabetic ☐

20. How much attention is given to teaching the letter sounds to trainee teachers?

1. Substantial time is spent and everyone's knowledge is assessed ☐ regularly during teaching.
2. Substantial time is used to teach but no emphasis is put on assessing their ☐ mastery.
3. Teaching is given according to needs. ☐
4. It is expected that everyone knows. ☐
5. This aspect of reading instruction does not get much attention in relation to ☐ other issues associated with instructions in basic reading skills.
6. It is only confirmed that letter names are known. ☐
7. Observing that everyone has learned the letter names used in English instruction. ☐

21. What is the college doing to help trainee teachers who have problems with letter sound knowledge to improve? Mark the most appropriate statement(s) (can be more than one).

1. Engaging reading experts ☐ 2.. Computer-based training in letters (language ☐ laboratories)
3. Extra lessons ☐ 4 Teaching of this issue not worth special attention ☐
5. All of the above ☐

22. Which of the following is the most accurate description of the difference between instructing the basic reading skill of local languages and English (tick in the box(es) next to the most appropriate statement).

1. Relatively small difference requiring little special attention ☐
2. Big difference because children have a lower mastery of spoken English ☐
3. Some letters have different sounds in English which should be pointed out. ☐
4. Letter sounds are more difficult to instruct in teaching reading of English. ☐

5. Letter sounds behave highly consistently in writing of local languages but practically no letter has the same sound everywhere in English. ☐

23. Have you completed any courses on specific learning disabilities during or after your professional education? 1. Yes ☐ 2. No ☐

24. Did these courses include reading deficits (dyslexia)? 1. Yes ☐ 2. No ☐

25. How much time is allocated to the teaching of reading instruction at your college?
1. Less than 10 hours of teaching ☐ 2.11-30 hours of teaching hours ☐
4. More than 30 hours of teaching ☐

26. How much time goes into training the basic initial reading skill such as letter-sound knowledge?
1. 0-3 hours ☐ 2. 4 to10 hours ☐ 3. More than 10 hours ☐

27. How much time goes into training the initial reading skill of local orthographies as a separate domain compared to that of English?
1. 0-3 hours ☐ 2. 4 to10 hours ☐ 3. More than 10 hours ☐

28. How much time goes into training the initial reading skill of English as a separate domain compared to that of local orthographies?
1. 0-3 hours ☐ 2. 4 to10 hours ☐ 3. More than 10 hours ☐

29. Is the time allocated sufficient enough to equip trainee teachers with pedagogical skills for teaching reading in early grades? 1. Yes ☐ 2. No ☐

30. Do you have a special department in your college to train teachers to identify and instruct poor readers? 1. Yes ☐ 2. No ☐

31. What reading programmes does your college follow?

32. How much time is spent on teaching reading methods in your college?
1. 0-3 hours ☐ 2. 4 to10 hours ☐ 3. More than 10 hours ☐

33. Please mark the important function of letter-sound knowledge for trainee teachers in (ZNL) so that they understand how it helps children.

1. To develop phoneme awareness Important ☐ Not Important ☐
2. To learn the basic starting block for reading skills Important ☐ Not important ☐
3. To learn accurate communication skills Important ☐ Not important ☐
4. To learn written and spoken language connections Important ☐ Not Important ☐

34. How are letter sounds/names in your college instructed to trainee teachers?

1. As the first and necessary knowledge everyone needs to show mastery ☐
2. As one of the important starting blocks for reading and writing of local languages ☐
3. As something most known and needs no special attention ☐
4. Not important because English letter names are well known by everyone ☐

35. The recommended and most efficient way to teach letter sounds in Zambian languages as instructed in your college.

1. Start with the instruction of English letter names ☐
2. Start with the instruction of Zambian language letter names ☐
3. Start with the instruction of letter sounds as they occur in English ☐
4. Start with the instruction of letter sounds as they occur in Zambian languages ☐

36. Have you attended a primary reading programme training?

1. Yes ☐ 2. No ☐

**PART C:** BARRIERS TO THE PROPER TEACHING OF READING IN COLLEGES OF EDUCATION? Indicate your answer on a scale from 1 to 5.

1. Significant problem 2. Problem 3. Slight problem 4. Not a Problem 5. Don't know

| No | STATEMENT | Significant Problem | Problem | Slight problem | Not a problem | Don't know |
|---|---|---|---|---|---|---|
| 37 | Availability of reference books | | | | | |
| 38 | Language of instructions | | | | | |
| 39 | Access to computers/Internet | | | | | |
| 40 | Shortage of trained lecturers reading | | | | | |
| 41 | Lack of access to training in reading instruction | | | | | |
| 42 | Ability of trainee-teachers to notice the differences instructions for learning to read in English versus. CiNyanja | | | | | |
| 43 | Sufficient time for instruction | | | | | |
| 44 | Duration of course | | | | | |
| 45 | Access to teaching and learning aids | | | | | |
| 46 | Lack of knowledge in reading instructions | | | | | |
| 47 | Syllabus/curriculum | | | | | |

THANK YOU FOR PARTICIPATING!

APPENDIX 11 Teacher Letter Sound Measurement Tool

## Teacher Letter-Sound Knowledge Assessment

Mark all the words which contain the sound of the CiNyanja letter (written at the beginning of the row of the alternative English words). Note that the sound may occur in more than one of the words in the row.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | /a/ | 1. man | 2. gardener | 3. table | 4. day | 5. fall |
| 2. | /e/ | 1. egg | 2. tree | 3. chair | 4. bad | 5. red |
| 3. | /i/ | 1. sea | 2. key | 3. until | 4. field | 5. machine |
| 4. | /o/ | 1. brother | 2. book | 3. long | 4. bloom | 5. brown |
| 5. | /u/ | 1. mud | 2. book | 3. proud | 4. ugly | 5. pure |
| 6. | /a/ | 1. sea | 2. chair | 3. father | 4. cat | 5. page |
| 7. | /e/ | 1. her | 2. fair | 3. than | 4. port | 5. edge |
| 8. | /i/ | 1. gin | 2. shift | 3. team | 4. meat | 5. kite |
| 9. | /o/ | 1. ball | 2. our | 3. one | 4. hot | 5. spoke |
| 10. | /u/ | 1. gun | 2. much | 3. pupil | 4. buy | 5. to |