Enhancing the Acquisition of Basic Reading Skills in Kiswahili Using GraphoGame

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Abstract

Many primary school children in Tanzania are failing to learn basic reading skills. Despite unprecedented efforts to improve the learning and teaching of literacy skills in the early grades made by the Tanzania government through its Ministry of Education, Science and Technology (MoEST), between 20 and 25 percent of grade seven (Standard[1] VII) learners complete primary education without having mastered the basic literacy skills in Kiswahili. As computer-assisted programmes have been proven to provide promising opportunities for the training of initial reading and spelling skills, an experimental study was conducted to establish the usefulness GraphoGame-Kiswahili (an ICT enabling tool) in assisting the learning of basic reading skills and spelling skills in Kiswahili. The study design followed a pre-test (baseline assessment)-intervention (training)-post-testing procedure. One hundred and eight first grade (Standard I) children from two schools—one experimental school (n = 49) and one reference school (n = 59)—participated in the study. The sample from each school was randomly divided into two groups—a control group and an intervention group. The control group learnt how to read through teacher instruction (CI) and the experimental group received reading instruction via the GraphoGame-Kiswahili. Lexical decision tests of written items (letter-sound knowledge, syllable and word recognition) and decoding competence (spelling skills) were used to determine the children's orthography knowledge. The results from the experimental school indicate that there was significant improvement (t (22) = -3.008, p<.01) in performance in the spelling test in the pre-test for the GraphoGame group and the size of difference in the means was large (eta squared = 0.291). Results further show that there was significant difference in letter/syllable identification mean scores for the CI group (t [22] = 13.692, p<.05, eta squared = .894).Repeated measures (ANOVA) analyses performed on game data logs, revealed significant improvement (p<.05) in all the reading-related skills assessed. The most effective intervention combined exposure of both the teachers and the children to the game. These findings support the use of GraphoGame-Kiswahili as a technology-assisted education game that could be applied in the real learning environment in Tanzania's primary schools.

Key words: GraphoGame, intervention, children at risk for reading difficulties, Kiswahili, Tanzania.

Introduction

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[1] 'Grade' and 'Standard' are interchangeable; this article uses the former.

Among African countries, Tanzania is the only one that has gone beyond political declarations and un-implemented language policies, and effectively promoted the use of national language as an official language in administration and education (Alidou & Brock-Utne, 2011). Kiswahili is the national language and the medium of instruction in the country's public primary schools. One potential outcome of this is Tanzania boasting of exemplary achievements in education and development of mother-tongue based literacy instruction. And yet, recent research shows that Tanzania is still far from ideal education outcomes despite educational strategies aimed to raise the level of literacy specifically among primary school children. For example, the major instruction goal of the first two years of primary education in Tanzania is to teach children how to read, write and numeracy (Education and Training Policy [ETP], 1995; Jamhuri ya Muungano wa Tanzania, 2015). In this regard, the primary school syllabus for teaching Kiswahili pays great attention to the reading and writing skills of grades one and two children. Moreover, reading and writing subjects are allocated more time than other subjects on the class timetable. The expectation is that by the end of grade two children would have acquired basic skills in reading. However, the reality is that many children still fail to learn the basics in reading. Research findings show that only a small proportion of the children can actually read competently. For example, about five percent of grade two children cannot identify even sounds or names of Kiswahili letters (Ngorosho & Lahtinen, 2010). Comparable findings were reported from the EGRA Baseline study (2013) that only eight percent of the pupils at the end of grade two were able to read with comprehension. In all, 2,214 grade two children were involved in the study (Nyirenda, 2014). The study results further established that many of the children do not attain reading skills effectively and efficiently; as a result, they do not read nor comprehend what they read. Most (98%) of the children, who participated in the survey, could not read, write or count at the expected level at that stage of schooling. The Education for All (EFA) Global Monitoring Report, further estimates that 27 percent of primary school age children who were in school in 2007 in Tanzania had not acquired the basic skills for reading (UNESCO, 2014).

The development leading up to facing reading difficulties can be identified quite early and very reliably years before children enter school (Lyytinen, Erskine, Kujala, Ojanen, & Richardson, 2009). As studies have now documented, the poor first-grade reader almost consistently continues to be a poor reader (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Juel, 1988; Torgesen & Burgess, 1998). Uwezo's studies have consistently affirmed that even a full cycle of primary education in Tanzania fails to guarantee adequate development of reading skills, and by the time children complete these seven years, between 20 percent and 25 percent still cannot read a grade two level Kiswahili story (Uwezo, 2010, 2011, 2012). Unable to read a simple story, these children are ill-equipped to take advantage of further learning opportunities. For example, about 5,200 children who were selected to join secondary education in January 2012 were unable to read or write (Itala & Mpandana, 2011). The consequences of a weak foundation in reading skills have a marked bearing on the children because they will inevitably join the ranks of illiterate adults.

Efforts to improve reading skills in the lower grades in Tanzania

The Tanzania government through its Ministry of Education, Science, Technology and Vocational Training has executed various plans aimed to improve the development of reading skills among children in the early grades in Tanzania. Most of the plans were intended to improve teachers' skills in teaching reading among grades one and two children. For example, in the 1970s a Primary Education Reform Project (popularly abbreviated MTUU), jointly provided by UNICEF/UNESCO and the Tanzania government, was launched. The programme involved a total of 10,000 in-service teachers who were then teaching in grades 1 and 2. The aim of this project was to improve the teachers' knowledge and skills to teach reading to the early grades. Specifically, the emphasis of the course was on the correct facilitation of the 3Rs, which are reading, writing and arithmetic (commonly referred to as KKK in Kiswahili, that is, *kusoma*, *kuandika* and *kuhesabu*). A teacher was only allowed to teach grade one and/or grade two if he or she had attended the course.

In 1981, the Ministry of Education and Culture through Swedish support launched another series of in-service courses to enhance teachers' competence and boost their confidence in teaching and learning of the 3Rs for grades one and two. An evaluation of the impact of the 3Rs training courses, which was conducted in 2000, showed that teachers were still ill-equipped with the necessary knowledge and skills for quality and efficient teaching of reading (and writing) in the early grades. Based on these findings, in 2000 UNESCO initiated a project on Reading for All that was popularly known as Reading and Writing for Critical Thinking. The emphasis was on participatory approaches to teaching, whereby children would fully be actively engaged in the teaching and learning process.

However, an appraisal of the project done in 2005 revealed that instruction in teaching literacy had not been given strong emphasis. For example, classroom teaching was stereotyped in that, firstly, it did not feature the actual classroom learning environment and, secondly, teaching was isolated by not providing room for activities outside the teachers' guides and the textbooks. The study also found that preparation for pre-service and in-service teachers did not provide effective literacy instruction of a transparent language like Kiswahili (Chediel, Dumea, Levira, Madumulla, Machange, Makundi, ...Urio, 2006).

In addition to lack of emphasis on literacy instruction in in-service programmes, the Kiswahili reading curriculum offered to pre-service teacher trainees is generalised and lacks a detailed consideration of how to teach early reading in Kiswahili (Bhalalusesa, Westbrook, & Luisser, 2011; Kitta & Fussy, 2013). During their two years of training, Grade 'A' teacher trainees (trained to teach in primary schools) learn how to teach reading using a synthetic phonics approach, starting with vowels or vowel sounds, and later assigning the vowels to different consonants to form syllables, simple words and finally short sentences (Bhalalusesa *et al.*, 2011). Such emphasis is in line with learning-to-read which requires knowledge of the sounds of the letters that eventually opens up the writing system of Kiswahili as transparent writing. Teacher trainees thus need to acquire knowledge on the role of phonemic awareness, phonics, and the related syllabic approach, which is good for learning the difficult to sound-out (and thus learn) consonant sounds and the initial assembly skills. They also need to know that for a transparent language such as Kiswahili, which has an almost straightforward letter-sound correspondence, it would be possible for the majority of children to master reading by the end of grade one

(Lyytinen *et al*., 2009). Nearly every letter in a Kiswahili word is pronounced, and every letter (or letter combination) maps one sound. Hence, children should learn how to read using one-to-one simple grapheme-phoneme connections (Alcock, Ngorosho, & Jukes, 2017; Amberber& Collins, 2002; Heine & Nurse, 2000).

Furthermore, research finding indicate that teacher beliefs have the potential of influencing instructional decisions and that in Tanzania's pre-school classes, for example, the teaching of reading revolves around direct and systematic phonics-syllabic/bottom-up instruction coupled with repeated practices, songs, use of pictures, look-and-say, and integration of reading and writing activities (Shukia, 2014). Findings further reveal that most of the children can learn to read and, hence, the pupils need strategies such as supplemental instruction, within-class mixing, retention, and ability grouping (Shukia, 2014).

For a training of teachers to be effective, classroom instruction and practices in teaching to read in the lower levels of primary education (e.g. pre-primary level, and grades one and two) should be designed with the goal of facilitating the learning process as much as possible for the learner. Morrow, Gambrell, Duke, and Nero (2011) suggest that one of the best practices for literacy instruction is the provision of appropriate instruction in core skills for mastering skills required for learning to read. Subsequently, MoEST in 2014 initiated a 3-year programme to implement the Global Partnership for Education Programme (Literacy and Numeracy Education Support Programme- LANES) for Mainland Tanzania along these lines. The main focus of the programme is to provide in-service training for teachers of grades 1 - 4 on appropriate instruction for reading, writing and arithmetic (3Rs) skills for children aged 5 - 13 years.

Implementation partners of the ministry are the Education Quality Improvement Programme in Tanzania (EQUIP-T) and Global Partnership for Education, Literacy and Numeracy Education Support programme (GPE – LANES). The programme also involves conducting training for grades one and two teachers with the aim of strengthening early grade teaching and learning. One of the outcomes of the programme is that almost 1,851 teachers have been trained and grade one and two books have been developed, printed and distributed to 15,525 primary schools (United Republic of Tanzania [URT], 2014/2015). Other key results include improved teaching and learning of 3Rs among teachers, improved Education Sector Management in terms of processing school data through the national Education Sector Management Information System (ESMIS) platform, and heightened awareness among education implementers. As a result, a new curriculum for grades one and two was developed (EQUIP-T, 2015).

With recent advances in Information and Communication Technologies (ICTs), many new instructional games that claim to support development of early literacy skills are available. Such educational games constitute a promising way of providing new opportunities for learning the basic academic skills. In addition, they are open source for receiving new learning materials for reading to acquire full literacy. In this regard, a range of computer-mediated or computer-assisted activities for reading and spelling have been developed in the last few years with promising results (e.g. Leong, 1992).

Computer-Assisted Instruction, which can be found on the internet, is a programme designed to provide instruction on how to read to learners with reading disabilities. The pupil uses the mouse to click the best word of the three presented for each blank to complete the sentence so that it makes sense. If this activity is used for instruction, the programme gives positive feedback for correct answers or shows the pupil which answers are wrong and then gives the correct choice. In the case of Tanzania, there are programmes such as Ubongo kids which teach mainly mathematics and storytelling.

The present study addresses the question of whether children experiencing difficulties in learning to read and write can benefit from a computer-assisted training tool and intervention for learning to read Kiswahili, namely GraphoGame-Kiswahili.

GraphoGame (GG) – a support tool for learning and teaching basic reading skills.
GraphoGame was initially devised and developed for the transparent orthography of the Finnish language. It is a child-friendly, computerised intervention and a training tool that trains learners in phonemic awareness through sound-letter connections. The actual game is based on a clear and simple idea. When the child starts the game, he/she hears speech sounds (it is preferred that a child wears headphones to ensure clarity in sound) and sees a selection of written symbols on the screen. The headphones worn by the child should always be of good quality so that there is clarity in the sounds the child hears. At the same time, representations of the speech sounds in print format appear on the screen. The child is expected to select the written symbol that corresponds to the speech sound. After the acquisition of letter-sound correspondences, GraphoGame progresses to larger grapheme-phoneme combinations such as syllables, and eventually to words, and pseudo-words (for further details, see Lyytinen *et al*., 2009). The aim of the stages of learning to read rooted in GraphoGame is for the child to acquire the alphabetic principles of the language. GraphoGame teaches the learner basic literacy skills: grapheme-phoneme connections based on synthetic and analytic phonics instruction. GraphoGame has proved to be an effective computer-assisted intervention for children learning to read in Finnish. Today more than 300,000 children have played the game in Finland and very few have failed to benefit from it (Lyytinen *et al*., 2009).

Studies carried out in Finland showed initially encouraging results (Lyytinen, Ronimus, Alanko, Poikkeus, &Taanila, 2007). In 2004, Maria Taanila (cited in Lyytinen *et al*., 2007) conducted a pilot study with kindergarteners, who were non-readers or had minimal reading ability. The aim of the study was to investigate the effect of GraphoGame on children's ability to blend sounds. The study was experimental, with a switching format design. As one group played GraphoGame, the other group played a maths game as a control game. The groups swapped the games after one or two weeks, when a test was administered to determine the performance level of the groups. The results showed that both groups improved their blending performance during the GraphoGame playing period. Generally, non-reading children acquired basic reading skills after less than four hours of playing GraphoGame. In contrast, there was no improvement in blending performance during the maths game period.

More promising results were reported from a study by Alanko and Nevalainen (2004 cited in Lyytinen *et al.*, 2007). The study involved first grade children (N = 41, non-readers), whose reading was assessed using a standardised reading test. The study was experimental and half of the non-readers served as an experimental group and received intervention by playing GraphoGame, while the remaining children served as a control group. The results showed that, although letter knowledge was a significant predictor of gains in reading acquisition, GraphoGame made a highly significant additional contribution to acquiring reading skills. This demonstrates that GraphoGame is an effective intervention that can help children learn to read independent of letter knowledge. In fact, the children who played GraphoGame outperformed those who received normal classroom instruction. Today a number of subsequent studies have demonstrated how the more recent versions are quite effective in supporting reading acquisition (e.g. Jere-Folotiya, Chansa-Kabali, Munachaka, Sampa, Yalukanda, Westerholm, Richardson, Serpell, &Lyytinen, 2014; Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2011)

GraphoGame has shown its efficiency not only in Finnish language but also in other transparent European languages, including German (see, for example, Brem, Bach, Kucian, Guttorm, Martin, Lyytinen, Brandeis, & Richardson, 2010; Huemer, Landerl, Aro, & Lyytinen, 2008). GraphoGame has also proved effective in supporting reading acquisition in English, as Kyle, Richardson, Lyytinen and Goswami (2013) have demonstrated. Moreover, GraphoGame has been extended successfully to African languages that have similar regular and transparent orthography to Finnish, such as ciNyanja in Zambia (Ojanen, Kujala, Richardson, &Lyytinen, 2013; Kaoma, 2008), and Kikuyu and Kiswahili in Kenya (Otieno, Lyytinen, & Richardson, forthcoming). ciNyanja adaptation of GraphoGame (initially known as Sewero La-ma-u) was piloted in Zambia in 2005 with a series of intervention studies (Ojanen *et al.*, 2013) for grades 1 - 4. Participants in the pilot study represented the lowest 15 percent of their grade level in spelling skills. The pilot study aimed to answer two questions. The first was whether a computer game could benefit Zambian children to improve their literacy skills and the second was what the game could reveal about the possible explanation for children's low performance in literacy. Intervention study (Chilufya, 2008) with first grade children with poor reading skills showed increased performance in spelling and orthography tasks after the intervention. One sub-study (Ojanen, 2007) focused on eight girls in grades one and two with compromised ciNyanja language reading skills and explored possible reasons for their difficulties in literacy skills. The analysis of the GraphoGame game logs indicated that children were still learning English letter names despite the new language policy in Zambia that children should learn reading using a local language. The main results from the study indicated that children's performance in literacy skills improved in the post-tests right after the intervention, although the improvement was not found during the follow-up testing (Ojanen, 2007).

Kaoma (2008) extended the use of Sewero La-ma-u with eight children with compromised reading skills in grades three and four. The study aimed to find ways to improve the quality of literacy instruction and introduce a method of remedial teaching for children with reading difficulties. Children's literacy skills were assessed through a spelling test and orthography test before and after the intervention. The final results indicated that those children who had problems in discriminating vowel phonemes in the pre-testing assessment improved spelling

and orthography skills during the intervention. Hence the game proved useful and complemented classroom instructions. The most recent publications reveal affirm that teachers optimise the end results once they also play the game (Jere-Folotiya, 2014; Jere-Folotiya *et al*., 2014).

Puhakka (2015) examined how GraphoGame could offer practical solutions to early reading challenges in multi-lingual Kenya. The study sample was identified from children who had the lowest scores in orthography and spelling tests that were conducted to establish the children's pre-test performance. While a group of children played either a Kikuyu or Kiswahili adaptation of GraphoGame, another group played sports in the school playground. Both groups played the games for at least four hours. The pre-test results showed that most of the children were at risk of developing reading problems due to low performance in letter, word and spelling tests. Secondly, children who were exposed to GraphoGame adaptations improved their orthographic skills (p<.001) compared to children who did not benefit from such intervention.

This article adds to the already existing findings from the Kiswahili adaptation of GraphoGame (GraphoGame Kiswahili) that were reported from Kenya by Puhakka (2015). The overall objectives of the study conducted in Kenya were, firstly, to determine the current situation facing early grade teachers in the classroom with the aim of developing appropriate methodologies (including proper pronunciation of letter sounds) that could help them optimize early reading acquisition in the multilingual classroom environments. The education system in Kenya mandates a bilingual approach that allows a mother-tongue or the language of wider communication to be used as the medium of instruction in the first three years of primary school (grades 1–3). During this period, English and Kiswahili are taught as subjects in schools where the mother-tongue is used as language of instruction. According to the study, after grade three, the mother-tongue is neither taught as a subject nor used as a language of instruction. Such a situation is different from the education system in Tanzania where Kiswahili is the medium of instruction in public primary schools. The second objective of Puhakka's study was to establish the level of early literacy skills of the pupils and explore how digital learning environments can enhance early literacy acquisition in the classrooms, both in the mother-tongue (L1) in the case of Kikuyu and second language (L2) in the case of Kiswahili. The study conducted in Tanzania involved a society where Kiswahili is used both as a language of communication in the homes and a medium of instruction in the classroom. The current study presents the results from a small-scale study that was conducted in an urban setting in Bagamoyo in the Coastal (Pwani) region of Tanzania.

Bagamoyo is home to various ethnic groups including the Wakwere, Wazaramo, Wazigua, Wamaasai, and Waswahili who form the largest group of the people living in this area. Most previous studies that were conducted in Bagamoyo focused on the contribution of the home living environment and home literacy environment on children's reading, writing and phonological awareness skills (Ngorosho, 2010; Ngorosho, 2011; Ngorosho & Lahtinen, 2010). The finding from the current study adds value to earlier findings from previous studies that revealed that home environment variables related to socio-economic status (fathers' education and house wall and books) predict reading and writing. Children from low socio-economic levels showed lower achievement in reading and writing tests than children from higher socio-

economic status. This study aimed to find out whether a technology designed to help children learn to read (GraphoGame) could be used as an instructional tool to enhance the reading aptitude of even children who come from poor backgrounds and have been identified at risk of failing to develop reading skills.

Methodology

The study design

The study design was experimental and it followed a pre-test (baseline assessment)-intervention (training)-post-testing procedure (Figure 1). At the baseline, a class-wise testing that involved testing all grade one children was carried out to establish the children's basic reading skills through letter and syllable identification, word identification, and early spelling skills. The tests used in the testing procedure were reading and spelling tests that were modified from already existing lexical decision tests of written items (letters-sound identification test, syllables and words identification tests) that were developed and used in the previous studies (Ngorosho, 2010). The tests were further used in a large study that investigated the relationship between home environment and reading and writing ability among primary school children in rural Tanzania (Ngorosho, 2011). The alpha coefficient for the reading and writing tests used in the current study was .96 for letter sound test, .78 for syllable identification, and .75 for word identification. The tests were administered in school classrooms not being used for teaching at the time. After the testing, a pupil was given a pencil, an eraser, and a pencil sharpener as a gift.

Validity of the tests was also established. Heale and Twycross (2015) define validity as the extent to which the information obtained from assessment instruments, like tests or methods such as observation enable the researcher to accomplish the purpose for which the information was collected. The study used criterion-related validity, whereby the performance of children obtained from the class-wise tests was regarded as an added advantage for predicting the baseline level of children's reading and writing skills for identifying children at risk of failing to develop reading and writing aptitude.

The results from class-wise assessment helped to identify children who lagged behind their classmates in the acquisition of the literacy skills and, thus, needed further training and educational intervention. The lowest performing children who were identified as low achievers from each school participated in the intervention. The cut-off point for a child to be considered a low achiever and, thus, be recruited for the study was a score of less than 10 correct items in the letter/syllable and word identification tests.

The children selected were then tested again (pre-test) before the intervention to establish their baseline performance in literacy skills. Pre-testing was necessary from the fact that teaching and learning had continued for one month more after the screening exercise. These children were randomly assigned to two groups, GraphoGame (GG) and Classroom Instruction (CI). While one group played the GraphoGame Kiswahili (the player group) game, a comparable group (control group) of children with similar initial skills served as a control group under the supervision of a Kiswahili subject teacher. Kiswahili teachers at the experimental school were

trained in themes such as reading ability—poor readers versus learning disabled, reading in different types of writing systems (Orthographies), methods for teaching reading in transparent orthographies including Kiswahili, GraphoGame (GG) as a supplementary, computer-based phonics learning game that promotes literacy development by teaching children to form letter-sound associations, and writing of stories that are compiled to form simple reading materials. Some of the simple books which had short and simple stories that were written by teachers were placed in a corner of a room "labelled" as a library.

Kiswahili teachers at the control school were left to use methods they usually deploy to teach reading in the classroom. Such methods included teaching of letter names which is followed by developing syllables and later words, and whole-word teaching method that was supported by using actual things and pictures. In all, five grade one teachers, three from the experimental school and two from the control school also participated in the study. The teachers' roles were to supervise the two groups—the GG practice group and the classroom instruction group. Intervention was provided for both groups in the school setting: a computer room was used by GG players for practising the game, and an empty classroom that was not being used for class teaching was used by a Kiswahili teacher for teaching the CI group.

The intervention involved alternating arrangement whereby after three weeks (or 15 school days), the groups swapped roles. Children who practised GG then received CI instruction and vice-versa. Children practised GG via Samsung Galaxy android mobile phones and used headphones to hear speech sounds. It is advisable that the headphones worn by the child should always be of good quality so that there is clarity in the sounds the child hears. The intervention was designed to fit into the general school timetables (i.e. within school hours) and was delivered by grade one teachers under the supervision of the researcher. The GG training was conducted in a computer room and each school implemented it at a convenient time that was agreed upon from the beginning of the study. For example, the control school conducted the training from 0800 to around 0900 whereas training in the experimental school started from 1000 hours to around 1100 hours. To make sure children participating in the study were not missing normal school teaching, the teachers worked extra hours after the normal school time for grade one children which was normally at 1100 am. Thus, study activities were carried out solely at a separate time from learning activities that were indicated on the school timetable. There was one specific teacher in each school who was responsible for supervising GG to ensure that each child played the game each day and at the required time.

After three weeks, the roles were changed (switching replication design). This gave all the children an opportunity to learn how to read using GraphoGame-Kiswahili. Children from both groups did the reading and spelling tests (described under the section about measures for reading and spelling skills) after the intervention to determine the effect of the training on their orthography/reading and spelling skills. The switching design completed a cycle for a group to participate in the study. This study presents results from two complete cycles (cycles 1 and 2), thus resulting in the collection of data from two separate groups of low-achieving children from both schools.

Participants

The study was conducted in the town of Bagamoyo in the coastal area of eastern Tanzania. The population of Bagamoyo in 2012, according to the latest national census, was around 35,000 people (National Bureau of Statistics [NBS], 2013). The main employment activities include fishing, agriculture, mining, and tourism.

The participants were grade one children who had already attended school for five months. A class-wise assessment (or screening) was carried out on first graders (n=180 and n=103) from two schools: School A, an experimental school with both phonics (via skilled teachers-) and GG-based intervention, and School B, the "reference" school (with GG-based intervention for children, and reading instruction that teachers usually use in their daily teaching practices). School A was selected as an experimental school as it had been one of the poorly-performing schools in Bagamoyo town in the national examinations—one at the end of grade four and the Primary School Leaving Examination (PSLE) done towards the end of grade seven for five consecutive years, from 2009 to 2013 (Bagamoyo Education Office, 2013). Conversely, School B (or the "reference" school) is regarded as the best performing school among the primary schools in Bagamoyo town in national examinations. This was responded by including teacher training in the poorly achieving school but only GG for the learners in the well achieving school.

The class-wise baseline test was used as a screening test: first to establish children's baseline performance before they participated in intervention programme that was conducted as remedial to improve their reading and spelling skills. Secondly, the screening results were used to identify low achievers in reading and spelling skill who would then be involved in the study. These groups of children were regarded as children who might be at risk of developing reading problems. Due to poor performance in almost all the tests, participants in the screening study represented the lowest achievers in relation to their grade level in reading and spelling tests.

One hundred and eight grade one children (55 boys and 53 girls) representing 38 percent of the lowest achieving children aged between 7 and 9 years (M = 7.18, SD =.53) were selected basing on performing poorly on two measures counted together. Children who had identified less than 10 correct items in the letter/syllable and word identification tests participated in the study. Initially, 68 children were selected from the experimental school (School A) to participate in the study. However, only 49 children (26 boys and 23 girls) were finally involved in the study. Nineteen children (28%) could not continue with the study. Among them, fifteen (22%) children had been transferred (together with children from another school) to a newly-opened school that was purposely built in a bid to minimise the problem of large class size in Bagamoyo town primary schools. Four (6%) children dropped out of school. Fifty-nine children (29 boys and 30 girls) represented the reference school (School B) in the study. The sample from each school was further randomly divided into two groups, which formed two cycles of the study due to lack of enough devices (Samsung Mobile phones) for all the children involved in the study. Whereas 24 children from School A and 29 from School B participated in the first cycle of the study, the second cycle involved 25 children from School A and 30 children from School B.
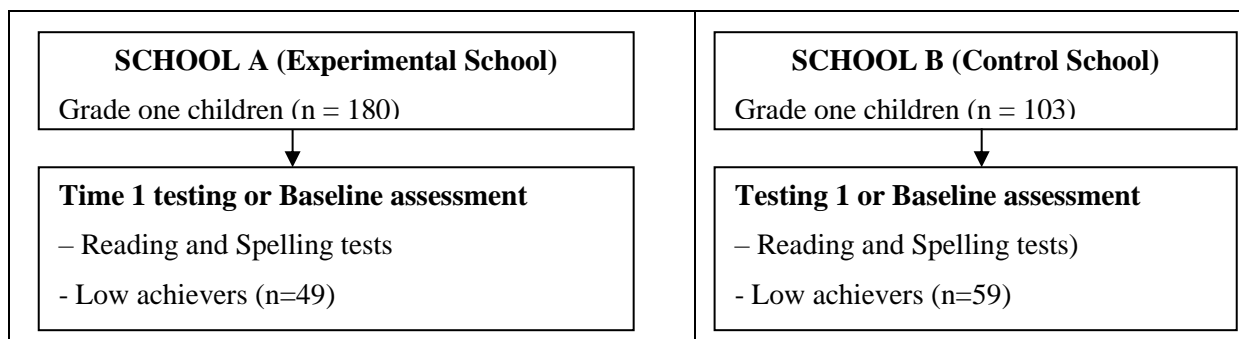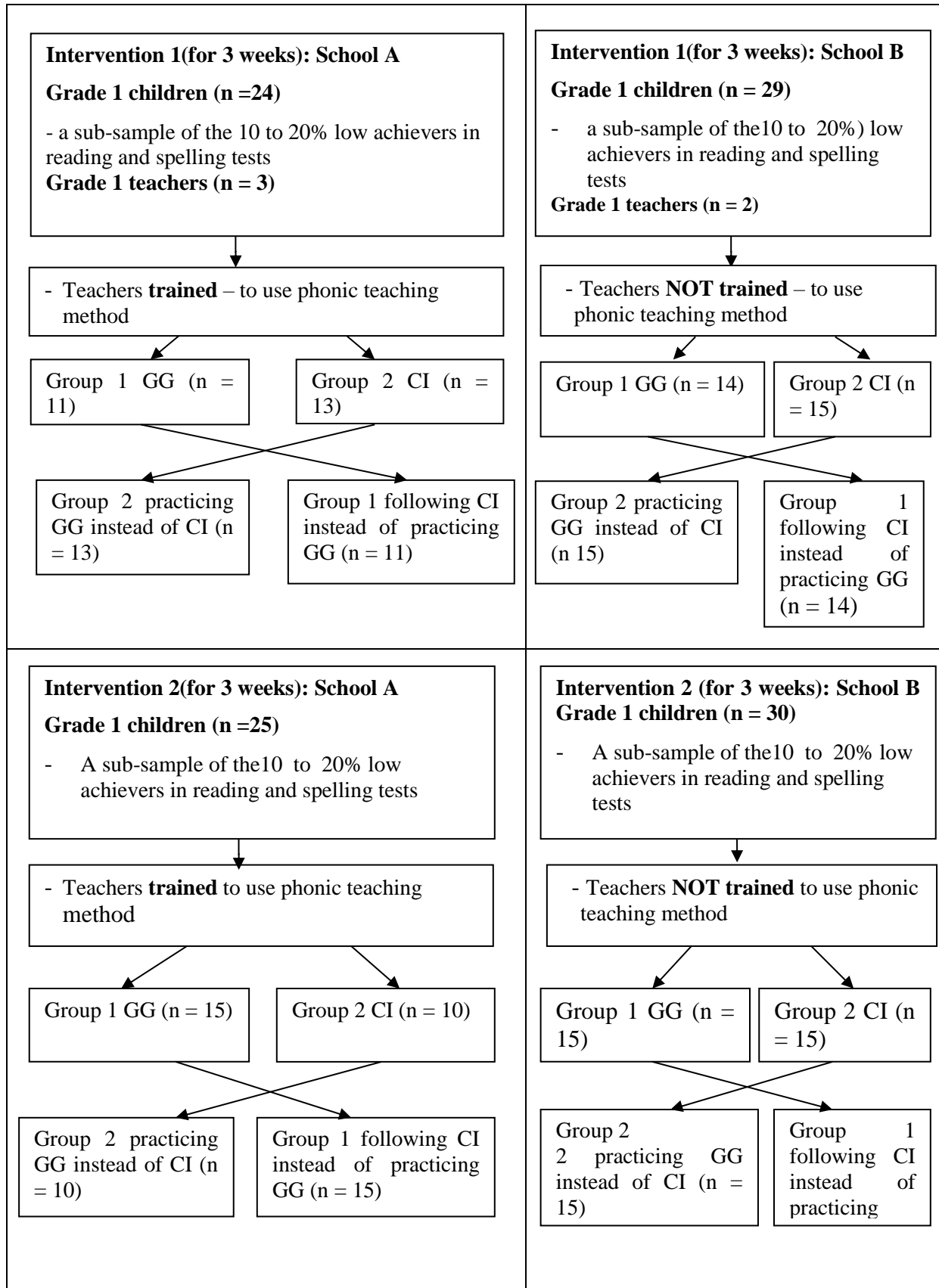
Testing Procedure

Measures for reading and spelling skills

Reading and spelling tests were a revised version of lexical decision tests of written items (letters, syllables, and words) described in Ngorosho (2011). The lexical decision tests involved deciding which letters and syllables are real and which ones are invented and not legal in Kiswahili. Pupils were asked to put a tick or a cross next to real letters/syllables/words and invented letters/syllables or words, respectively. There were 10 real letters and 10 real/possible syllables. Each correct answer was awarded 2.5 scores and the total score for letter sound and syllable identification test was 50. The word identification test comprised 10 real words and 10 invented words that had illegal/unacceptable structure in Kiswahili, and each correct choice was awarded a score of 2.5. The total score was therefore 50. Letter sound and syllable identification tests were administered first, followed by word identification test. For the letter reading test, capital letters were used in order to eliminate some pupils' confusion between lower case letters that have reflectional equivalence with each other (such as b and d) (Alcock *et al.*, 2000).

A spelling test

words included in the spelling test are written. The spelling test assessed the children's ability to write letters, syllables and words correctly. The test involved a tester reading aloud (dictating) the test items for pupils to write. The test included 10 letters that were read out as sounds, 5 syllables and 10 words that consisted of from two syllables (six words), to three syllables (four words). In administering the test, the tester first explained to the pupils that they would hear a letter sound, a syllable or a word twice before they were told to write down the letter sound, syllable or word. Secondly, they had to listen carefully to the items they were required to write. For this test, each correct item was awarded a score of 2 and the maximum score was 50.

SCHOOL A (Experimental School)	SCHOOL B (Control School)
Grade one children (n = 180)	Grade one children (n = 103)
Time 1 testing or Baseline assessment – Reading and Spelling tests - Low achievers (n=49)	**Testing 1 or Baseline assessment** – Reading and Spelling tests) - Low achievers (n=59)

Intervention 1(for 3 weeks): School A

Grade 1 children (n =24)

- a sub-sample of the 10 to 20% low achievers in reading and spelling tests
Grade 1 teachers (n = 3)

↓

- Teachers **trained** – to use phonic teaching method

| Group 1 GG (n = 11) | Group 2 CI (n = 13) |

| Group 2 practicing GG instead of CI (n = 13) | Group 1 following CI instead of practicing GG (n = 11) |

Intervention 1(for 3 weeks): School B

Grade 1 children (n = 29)

- a sub-sample of the 10 to 20%) low achievers in reading and spelling tests
Grade 1 teachers (n = 2)

↓

- Teachers **NOT trained** – to use phonic teaching method

| Group 1 GG (n = 14) | Group 2 CI (n = 15) |

| Group 2 practicing GG instead of CI (n 15) | Group 1 following CI instead of practicing GG (n = 14) |

Intervention 2(for 3 weeks): School A

Grade 1 children (n =25)

- A sub-sample of the 10 to 20% low achievers in reading and spelling tests

↓

- Teachers **trained** to use phonic teaching method

| Group 1 GG (n = 15) | Group 2 CI (n = 10) |

| Group 2 practicing GG instead of CI (n = 10) | Group 1 following CI instead of practicing GG (n = 15) |

Intervention 2 (for 3 weeks): School B
Grade 1 children (n = 30)

- A sub-sample of the 10 to 20% low achievers in reading and spelling tests

↓

- Teachers **NOT trained** to use phonic teaching method

| Group 1 GG (n = 15) | Group 2 CI (n = 15) |

| Group 2 2 practicing GG instead of CI (n = 15) | Group 1 following CI instead of practicing |

The measures for reading skills and spelling were administered in a computer-room not being used at that time. After the testing, a pupil was given an exercise-book and a small box of coloured pencils as a gift.

The test-retest reliability at a one-week interval in the previous study (Ngorosho, 2011) was .77 for letter reading, and .91 for word reading. The alpha coefficient for the reading and spelling tests in the current study was .78 for letter and syllable test, .86 for word reading and .75 for the spelling test.

Interventions

Two types of interventions, normal classroom reading instructions (CI) offered by the Kiswahili reading subject teacher and computer-assisted remedial intervention (GG) using GraphoGame-Kiswahili, were administered with the two groups (the control group and the player group), concurrently. Intervention for the control group was conducted in an empty classroom and the teacher followed the reading content and teaching method and procedure outlined and described in the Kiswahili syllabus for grade one. The classroom instruction intervention was conducted on all the days that the player group was practising GraphoGame-Kiswahili.

The Kiswahili adaptation of the Finnish GraphoGame was used as the computer-assisted remedial reading intervention to train children (and teachers from the experimental school) on the connections between letters and sounds of the Kiswahili language. It was originally planned that children would play GraphoGame Kiswahili for 10 to 15 minutes and between 3 and 5 times per day for at least 3 weeks. This would have given the children chance to receive an average exposure time of about 12 hours each at the end of the intervention. However, due to various reasons, the intervention period was reduced to three sessions of 10 minutes each in every school day in a week and the average total exposure time that children played GG ranged from 2 - 4 hours. Due to the changes in exposure time, the children did not get ample time to practise effectively all the activities embedded in the technology. The time suggested for a child to maximally go through enough levels of the game is one hour everyday for at least three weeks (Lyytinen *et al.*, 2009). This study analysed data for children who had two (2) hours or more and had played for 10 sessions or more. Some of the reasons for not reaching the targeted exposure time were, first, children and teachers being involved in school examinations and public holidays. Another reason was the requirement that children should participate fully in the teaching and learning of the subjects indicated on school timetable. Teaching and learning for grade one is allocated five periods of 30 minutes (or 150 minutes) each day during the school hours. One or two of the periods should be set aside for teaching Kiswahili subject. The Kiswahili syllabus directs that five 30-minute periods be set aside every week for teaching the reading and writing components of Kiswahili. According to educational policy, teachers are supposed to adhere to the timetable. In this regard, grade one teachers made sure that all the children attended normal Kiswahili classes at the allocated time on the school timetable. Therefore, it was not possible to use 50 minutes out of the 150 minutes that are allocated for reading and writing to administer the intervention activities. Based on this obligation, it was

necessary to re-organise the grade one teaching schedule to include half an hour extra time at school so that the children could at least participate in the study.

Lack of enough time also affected the classroom instruction-based intervention. Initially, the intervention would receive similar time as the GG practice (that is 50 minutes) but due to similar reasons, it lasted between 20 and 30 minutes. The teacher for reading and writing in grade one was also responsible for teaching English to the same grade. Therefore, during the time the local language reading instruction (Kiswahili, a consistent language) was on, the same children were instructed also to learn to read English (an inconsistent language). Learning of two different writing systems might cause unnecessary confusion among the children. Flash cards, real objects and reading aloud were some of the techniques that were used by the teacher.

The total exposure time (total time for playing the game) per day ranged between 20 and 40 minutes, depending on how much a child was motivated to continue playing the game, and also whether he or she was present at school. Early dropout in the lower grades has been a persistent trend, especially for children with reading difficulties. For example, basic education statistics show that 9,462 (out of 2,660,395) grades one and two children dropped out of school in 2012 (MoEVT, 2012).

Results

Descriptive statistics, independent-sample t-test and repeated measures ANOVA analyses were performed to examine the effectiveness of GraphoGame as a training tool and intervention for learning to read Kiswahili. The assumption was that children exposed directly or indirectly to GraphoGame Kiswahili (GG group) through their teachers would show greater improvement in their mastery of spelling and reading-related skills than control group students. For the experimental school, a CI group children received instruction from a teacher who had had received intensive training on GG and how to use the technology to teach reading. Furthermore, the teachers had also been trained on how to instruct reading through synthetic phonics approach. Teachers from the control school received basic knowledge about GG and how to supervise children while playing. Also, the teachers had not been trained in phonics approach to reading. Table 1 displays descriptive statistics for class-wise baseline performance in reading-related and spelling measures. Descriptive results obtained from pretesting of the children before being allocated to intervention groups and results from a t-test analysis are presented in various tables below.

Results from reading and spelling tests
As expected, the main finding from the baseline (class-wise) testing showed that children in the reference School B had better performance in the reading and spelling tests before intervention compared to children in the experimental School A. The reference school is considered the best performing school in Bagamoyo town.

Table 1: Baseline performance for all grade one children in the two schools (n = 283).

Poor performing school (n = 180)			Better performing school (n = 103)		
Measure	M	SD	Measure	M	SD
Spelling test	17.28	6.6	Spelling test	22.32	11.6
Letter/syllable identification	13.21	7.2	Letter/syllable identification	25.08	13.5
Word identification test	13.29	8.1	Word identification test	28.01	14.8

Table 1 indicates that the average performance for the experimental school was between 26 and 34 percent of the maximum score compared to average performance of between 44 and 56 percent observed in the control school. Table 2 shows performance from pre-tests that were done before the interventions:

Table 2: Pre-test results for groups of poor performers (n = 108)

Poor performing school (n = 49)			Better performing school (n = 59)		
Measure	M	SD	Measure	M	SD
Spelling test	8.06	3.7	Spelling test	15.15	5.5
Letter/syllable identification	7.06	1.7	Letter/syllable identification	16.73	8.7
Word identification test	6.78	2.5	Word identification test	17.80	10.3

Children from the reference school showed better performance than their counterparts from the experimental school. Mean variation between the scores was greater than that observed from scores in the experimental school and Levene's test indicated that the difference was statistically significant at $p<.01$ for both letter/syllable and word identification tests. However, the mean variation for the spelling test was not statistically significant ($p=.278$).

Further analyses include descriptive statistics for the intervention groups (GG and CI groups) which were conducted to determine performance at the end of intervention sessions. An independent-samples t-test was conducted to compare the test scores for GG player group and CI group from both schools.

Table 3: Pre-test and post-tests1 and 2 descriptive results for the GG and CI groups from the experimental school at intervention 1

Test	Pre-test				Post-test1 (before switching)				Post-test2 (after switching)			
	GG group (n = 11)		CI group (n = 13)		GG group (n = 11)		CI group (n = 13)		GG group (n = 11)		CI group (n = 13)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Spelling test	11.8	7.5	4.9	3.2	16.4	10.1	11.7	2.7	20.0	11.8	20.8	11.8
Let/syll ident	14.6	3.8	17.2	6.9	31.3	15.2	20.5	7.1	34.5	11.1	32.0	9.78
Word ident	13.6	6.8	13.9	6.5	22.2	12.3	26.2	9.3	31.6	12.4	32.6	12.1

Key: Let/syll ident = Letter/syllable identification; word ident = word identification

There was significant improvement in performance in the spelling test in the pretest for GG [M11.82, SD = 7.50; and CI, M = 4.92, SD = 3.22]; t(22) = -3.008, p<.01. The magnitude of difference in the means was large (eta squared = 0.291). Results further indicated that there was significant difference in letter/syllable identification mean scores for the CI group at intervention 1 (before switching to playing GG) [M =11.69, SD = 2.69], t(22) = 13.692, p<.05, eta squared = .894.

Table 4: Pre-test and post-tests 1 and 2 descriptive results for the GG and CI groups from the reference school at intervention 1

Test	Pre-test				Post-test1 (before switching)				Post-test2 (after switching)			
	GG group (n = 14)		CI group (n = 15)		GG group (n = 14)		CI group (n = 15)		GG group (n = 14)		CI group (n = 15)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Spelling	8.7	5.4	11.2	3.6	13.9	8.8	14.8	4.9	21.4	6.6	18.9	5.7
Let/syll ident	11.7	9.8	11.2	5.5	18.7	9.8	16.3	3.9	24.3	10.3	25.8	4.8
Word ident	13.4	7.8	13.7	7.01	19.9	8.2	15.3	5.1	24.4	10.2	25.9	7.5

Key: Let/syll ident = Letter/syllable identification; word ident = word identification

Although children's performance improved with regard to increased mean scores after interventions 1 and 2, analyses indicated there was no significant improvement in all the measures.

The second cycle of the study started immediately after the two groups had completed six weeks of the first cycle intervention. Twenty-five (25) children (GG group, n = 15; CI group, n = 10) from the experimental school and 30 children (GG group, n = 15; CI group, n = 15) from the reference school participated in this part of the study. Descriptive statistics from the tests are presented in tables 5 and 6:

Table 5: Pre-test and post-tests1 and 2 descriptive results for the GG and CI groups from the experimental school at intervention 2

Test	Pre-test				Post-test1 (before switching)				Post-test2 (after switching)			
	GG group (n = 15)		CI group (n = 10)		GG group (n = 15)		CI group (n = 10)		GG group (n = 15)		CI group (n = 10)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Spelling test	10.7	6.7	10.8	3.6	15.3	9.1	14.0	6.5	18.3	10.5	23.0	16.7
Let/syll ident	14.0	4.1	15.2	3.5	28.8	14.6	22.4	6.6	31.6	11.7	33.5	13.3
Word ident	12.6	7.6	13.3	7.1	21.8	11.6	28.0	9.9	26.8	13.5	36.3	11.6

Key: Let/syll ident = Letter/syllable identification; word ident = word identification

Table 6: Pre-test and post-tests 1 and 2 descriptive results for the GG and CI groups from the reference school at intervention 2

Test	Pre-test				Post-test1 (before switching)				Post-test2 (after switching)			
	GG group (n = 15)		CI group (n = 15)		GG group (n = 15)		CI group (n = 15)		GG group (n = 15)		CI group (n = 15)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Spelling	8.0	4.2	14.3	3.8	10.7	4.5	19.2	3.4	17.8	4.3	18.3	4.7
Let/syll ident	12.4	10.1	9.1	5.6	14.8	5.3	14.4	4.4	19.0	4.0	18.8	4.5
Word ident	17.7	13.5	13.1	5.9	16.8	12.4	19.8	7.3	23.2	10.7	24.1	7.6

Key: Let/syll ident = Letter/syllable identification; word ident = word identification

Analyses of scores from both schools indicate that children's performance increased in terms of mean scores from pretest in both interventions. However, t-test analyses showed no significant difference between the mean scores.

Usefulness of GraphoGame Kiswahili on the acquisition of reading skills

To find out the effect of GraphoGame on enhancing reading skills, repeated measures analysis, ANOVA was performed on game logs obtained from those children who played two hours or more within 10 sessions or more. The children's level of letter sound and syllable and word reading skills at the pre-assessment stage (assessment Time 1) were measured before practice (intervention) session one (assessment Time 2), session two (assessment Time 3), and session three (assessment Time 4). The practice sessions are regarded as interventions because the children were exposed to and practised various letter sounds (e.g. *o, e, j, k, g*), syllables (for example, *bu, ni, ma, to*) and words including word formation (2 syllable words of CVCV structure, e.g. *bata* "duck", and three-word syllables of CVCVCV structure e.g. *wizara* "ministry") before assessment. These items are included in the game content. Hence, the independent variable in this analysis refers to the correct selection of items of letter sound and syllables, and word reading. When the child makes a correct selection, she or he gets a score. If the choice made is wrong, the same target item is repeated, so that the child gets another chance of playing that particular item. Items are repeated in different order, with different incorrect options again and again until the child is able to choose the correct symbols without any errors. The independent variable is the assessment sessions (Time 1, Time 2, Time 3, and Time 4). The result of GG practice on letter sound knowledge and word reading is presented in tables 7 and 8:

Table 7: Effect of intervention on letter sound knowledge for the four assessment sessions

Testing sessions	M	SD	F df =1/24		Eta Squared
Testing 1 vs Testing 2 (n = 25)				ii	
T1	3.04	2.19	24.27*		0.50
T2	5.20	1.66			
Testing 1 vs Testing 3 (n = 24)	M	SD	F df = 1/23		Eta Squared
T1	3.00	2.23		iii	
T3	4.88	2.19	7.81*		0.25
iv.				vii.	viii.
Testing 1 vs Testing 4 (n = 19)			F df =1/18		Eta Squared
T1	3.11	2.45		xi.	
T4	5.58	2.19	10.97*		0.38

*p<.05

The children in both schools registered significant improvements during the practice period (from pre-assessment to assessment Time 2, Time 3, and Time 4) as indicated by the overall effect of time within subjects on letter sound and syllable and word reading (t7 and 8).

Since there were two experiments (from School A, the experimental school, and School B, the reference school) and children who played GG were from both schools, it was necessary to check the children's performance via GG logs. No significant differences between the school groups were found in any of the practice sessions. Mauchly's Test of Sphericity indicated that the variance did not meet the sphericity condition (p=.000), but due to two level factor, the assumed results of sphericity within subjects could be used.

Table 8: Effect of intervention on word reading for the four assessment sessions

Testing sessions	M	SD	F df =1/24		Eta Squared
Testing 1 vs Testing 2 (n = 25)				xi	
T1	9.20	8.15	6.55*		0.21
T2	12.16	8.37			
Testing 1 vs Testing 3 (n = 23)	M	SD	F df = 1/22		Eta Squared
T1	9.83	8.19		xii	
T3	14.26	7.16	21.94*		0.49

xiv.			xvi	xviii.
Testing 1 vs Testing 4 (n = 17)			F df =1/16	Eta Squared
T1	10.88	8.26	xx	
T4	16.24	6.43	12.11*	0.43

*p<.05

Discussion

The aim of the present study was to examine the usefulness of GraphoGame as an instructional tool and intervention for supporting the acquisition of basic skills for reading Kiswahili. Although learning to read the Kiswahili language should be relatively easy due to its highly transparent orthography, not all the children enrolled in school learn to read the language without facing difficulties (Ngorosho, 2011; Ngorosho & Lahtinen, 2010; Uwezo, 2010, 2011, 2012). Children are not learning the sounds of the language which are core skill requirement for learning to read Kiswahili. As a result, they fail to develop the knowledge that letters correspond to sounds. Consequently, children do not understand the process of turning letters into sounds, and the sounds into syllables, and finally into words. Although various in-service training and intervention programmes on how to teach reading in the early grades have been provided to the teachers, children continue to perform poorly in reading skills.

Various studies indicate that children improve in reading and spelling skills after receiving intervention and training through GraphoGame in a relatively short time of 2 - 5 hours. The findings reported in this study were obtained from children, who played GraphoGame for at least two hours or more within 10 sessions or more. The initial idea was that the intervention period would be extended to at least 12 hours (after two rounds of three weeks each) to achieve more positive learning outcomes. Moreover, instead of obtaining and analysing data for 108 children as initially projected, only about one-fifth of the data was considered satisfactory for analysis in terms of the exposure time (the actual time that children played the game). Making changes to the school timetable to accommodate research activities that require children to participate during school hours also posed a challenge. The official Kiswahili syllabus requires that five 10 periods are set aside every week for teaching the reading and six periods for the writing components of Kiswahili, and each period lasts for 30 minutes. According to educational policy, teachers are supposed to adhere to the timetable; this practice deprived the children of sufficient time to participate in the study fully, especially in the intervention sessions.

Nevertheless, a noteworthy observation from the post-test assessment is that the poor performance in the reading and spelling tests displayed by the children in the pre-test assessment significantly improved after the interventions and especially after practice and training on the GraphoGame. Although children's performance in the reading and spelling tasks improved immediately after intervention 1, the effect of the intervention did not last to the second intervention session. The impact of GG practice was observed even after Time 4 testing sessions. The long lasting impact of GG on letter knowledge and word reading skills can be

attributed to playing/exposure time the child had to learn the reading skills from the content included in the GG.

The results reveal that children's letter-sound knowledge and word reading improved significantly. This means the players improved their knowledge of letters and words even in the extremely short time. According to Lyytinen (2009 cited in *Newsletter*, May 2009), children who performed poorly even after training and practice might have needed more time and repetition to learn letter-sound correspondences, which is the most essential skill in learning to read. Children's individual differences in reading performance depends on the child's memory for sounds and the rate at which he or she can retrieve the sounds from short-term memory (Torgesen, 1985).

Although the Kiswahili syllabus for primary schools encourages a synthetic phonics approach to reading, the normal way of teaching letter reading in most grade one classes in Tanzania is through Kiswahili letter names. Emphasis is put on reading the letters with addition of /e/ (or /a/) sound on consonants; for instance, /b/ will be read as /be/, /d/ as /de/, /g/ as /ge/, and so on. In this regard, it might have been difficult for children in this study to acquire the concept of letter sounds (e.g. /b/ instead of /be/, /d/instead of /de/ and so on, effectively within a short time of training. Poor performance in tasks related to the identification of letter sounds in Kiswahili was also reported in a study that aimed to identify children at risk of developing reading problems (Kalanje, 2011). The study was a longitudinal design and the initial study was conducted when children were half-way through grade one and the follow up was carried out when children were half-way through grade two. The results indicated that there were some children in mid-grade one and in mid-grade two who had not yet mastered the tasks of assessing letter sounds. This was revealed by minimal mean scores (M=4.8, SD=3.3 from the initial study, and M=4.6, SD=2.3 from the follow-up study). However, a substantial number of children from the present study acquired the skills of spelling sounds, syllables and words correctly as a result of the interventions. This was revealed by an increase in scores gained in the post-test assessments and reflected by a rise in mean scores (tables 3, 4, 5, 6, 7, and 8).

The improvement in reading and spelling for the children who played GraphoGame compare favourably with those reported in previous reading intervention studies conducted in transparent languages of the Bantu origin (Chilufya, 2008; Kaoma, 2008; Ojanen, 2007; Ojanen, Kujala, Richardson, &Lyytinen, 2013; Puhakka, 2015). As Kiswahili has a consistent orthography, it was expected that training through GraphoGame would enable the children to store the core skills for correct letter sound, syllable and word recognition and spelling. The results for the intervention in both cycles of the present study show that there was significant improvement in the reading and spelling skills. The children were able to acquire the basic skills for reading and spelling within a relatively short time of about two hours of exposure to the GraphoGame.

Although grade one children had been to school for about five months, they had not been able to acquire as much skill in reading and spelling as they did within a relatively short time of playing the GraphoGame. In this regard, the improvement in letter/syllable and word reading and spelling skills provides evidence that the GraphoGame can serve as a practical training tool

and remedial procedure for teaching children to decode the straightforward correspondence between letters and sounds in the transparent language of Kiswahili.

Furthermore, there was significant improvement in the mean scores in school achievement (with regard to pre-test and post-test scores) among children at the experimental school compared to their counterparts from the control school. In consequence, the children's performance in school examinations near the end of grade one in 2013 showed that all the children were promoted to grade two in January 2014 because they had attained the standard pass rate in the Kiswahili reading and writing tests. On the other hand, two girls and one boy from the reference school could not obtain the pass-rate standards in Kiswahili; consequently, they were obligated to repeat grade one in 2014.

Limitations

The current study is so far the only pilot study conducted in Tanzania using GraphoGame™ as a tool for teaching basic reading skills. The study was confined to two schools in an urban setting. Therefore, the sample was not representative of the entire primary schools population of first grade children most of whom are found in the rural areas. Further research should seek to minimise this by including also the rural schools as the use of urban schools only can be a source of uncontrolled bias.

Some practical problems that children faced during the GG practice sessions can be attributed to differences of culture and technology. GraphoGame™ was designed in Finland where children are exposed to technology from home even before they start school and at an early age. This is unlike the children that participated in this study, whose exposure to technology is very limited. Based on this difference, it is possible that Tanzanian children in this sample may have needed more time to learn the rules and adapt to the game. One possible solution to this cultural difference is to introduce GraphoGame™ as an independent supplementary learning activity to support the current curriculum used in government public schools. It will support the implementation of the Curriculum for Basic Education Standard I and II (URT, 2016). This means more frequent exposure to the game both during the normal school teaching and learning sessions and also at home where parents could assist in supervising their child to learn how to read via GraphoGame. This might raise the status and standards of literacy learning of Tanzanian children. With the large number of learners in a classroom, the game can be played by the children without the direct supervision of the teachers.

GraphoGame is trademarked and, therefore, it is not a technology that uses open source software. However, the inventors (and therefore licensors) grant the end-user the right to install the software product on recommended devices. The end-user can also make copies of the software product as may be necessary for backup and archival purposes. Under such licence agreement, several language versions of GraphoGame have been developed and used in both developed and developing countries. Zambia is one of the countries in Sub-Saharan Africa that has benefited significantly from the licence agreement scheme. Adaptations of GraphoGame have been developed in local Zambian languages (e.g. ciNyanja, ciBemba) to support children struggling with learning basic reading skills. GG has also being piloted in rural areas and even

adults have shown interest in learning to read with the game. Currently, there is a project that focuses on developing mobile phone-based service teacher training. Teachers can use mobile phones to learn essential knowledge for good literacy education

Conclusion

Two important issues deserve mention here. First, there was significant improvement in children's performance in spelling and letter sound/syllable measures in the experimental school. Although the improvement observed in the mean scores was insignificant in the other measures and also at the reference school, it suffices to say that children learnt something from the game and interventions. Second, the effect of exposure time for playing GG was observed after every practice session which was also the intervention session for children playing the game. With this finding, GG seemed to be useful, and it is a technology-assisted education game that could be applied in the real learning environment in Tanzania's primary schools. Significant improvement in letter–sound knowledge and word reading skills was a result of repeated exposure times through GG practice. The main goal of the study was to introduce GG work in Tanzania and the challenges with literacy instruction in the country.

Based on the findings of this study, it must be acknowledged that children fail to achieve proficient reading skills as a result of inadequate reading instruction. Prominent improvement observed from the experimental school confirms that progress was most noticeable when both the children played the game and the teachers used the phonics approach as an appropriate reading instruction for learning to read Kiswahili. Intervention conditions in which both the children and the teachers were exposed to the game produced significant effect on both the reading and spelling skills. This finding provides an indication that learning of basic reading skills is effective also when teachers are adequately trained on the suitable reading instruction for teaching early literacy. For this to take place effectively children need to be taught the letter-sound correspondences in a local language with transparent orthography like Kiswahili.

Learning how to read is also complicated by limited access to reading materials, and large classes. The results point strongly to the need for the government to ease the burden on teachers by finding the best ways to make teaching and learning easy for both children and teachers, who are at times overwhelmed by having to teach so many children. From the study results, GraphoGame seems to be one of the best ways. GraphoGame can be used as a tool for supplementing the acute shortage of reading materials in Tanzania's primary schools. The game provides children with reading practice which they lack even when they have developed adequate reading skills. Children do not have interesting material to read for them to automatise their skills to become functional for reading acquisition. GraphoGame will provide teachers with additional assistance that will help children to learn important letter-sound correspondences, then syllables and simple words, before gradually progressing to increasingly longer words (Lyytinen *et al.*, 2009).

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