1. A SHONA LANGUAGE MOBILE APPLICATION TO FACILITATE READING AMONGST DYSLEXIC LEARNERS

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Abstract

Dyslexia, a neurological learning disorder affecting one's ability to read, write or speak, is the most common learning disability experienced by children and adults. Various researchers have reported on the high illiteracy rates amongst dyslexic adults in Zimbabwe due to the inadequacy of existing intervention programmes. This research was conducted to explore the benefits of integrating assistive technological solutions with existing intervention programmes to alleviate some of the effects of dyslexia. Using Design Science Research Methodology (DSRM), a Shona Android mobile learning application for primary school learners with dyslexia was developed to foster learning and help children improve some of their fundamental skills, such as reading comprehension, orthographic coding and visual motor integration skills. The Application helps teach orthography, grammar and phonology of the Shona language with the use of the alphabet and its character sounds, vowels, consonants and parts of the Shona speech such as nouns, verbs and adjectives. Quantitative (questionnaires, observations) and qualitative (interviews) sampling techniques were used in the evaluation phase of DSRM to uncover significant information about learning outcomes and discover conclusive findings about the Application. The research concludes that assistive technological solutions hold promising prospects for learning for dyslexic learners.

Keywords

Mobile App, dyslexia, Shona, assistive technological solutions

Introduction

The ability to read is the foundation of all further learning; hence, it is an essential skill that all learners must be equipped with at school. It is a skill that must be utilised daily in today's modern world, and people who do not possess it often find themselves marginalised (Mulundu et al., 2021), whereas for some, learning to read is an easy task, whilst for others words and letters just do not seem to make any sense regardless of how hard they try to understand them (Galla, 2018). This is often a characteristic of a condition commonly referred to as dyslexia.

Dyslexia is defined as a neurological learning disability that is characterised by difficulties with phonological processing, accurate word recognition, decoding how the speech sounds relate to the letters or words and poor spelling despite having normal or adequate intelligence (Conde, 2019). Learners with dyslexia often succeed academically if they are put under intervention programs such as the inclusive learner programs that cater for diversity among learners or the specialised education programs (Araújo & Faísca, 2019). Despite the availability of intervention programmes, it is unfortunate that there is still an attainment gap between learners with dyslexia and their peers in Zimbabwe.

The percentage of the global population with dyslexia varies in different reports, depending on how dyslexia is interpreted. However, most of those reports estimate that between 15% to 20% of the world's population is dyslexic (Rahim et al., 2018). The average primary school class in Zimbabwe consists of 36.41 learners (Wadesango et al., 2016). It can, therefore, be estimated that each class has between 5 and 7 dyslexic students. Most mainstream schools have implemented either a full or partial inclusive learner program (Nkomo, 2018). The full inclusive learner program is one in which students with special education needs are taught in general education classes and given full access to the curriculum, whilst partial inclusion entails teaching dyslexic pupils with the mainstream class for some activities, and withdrawing them for some activities that require more demanding or specialised intervention (Gibby-Leversuch et al., 2021).

Despite implementing all these measures to cater for students with various reading difficulties, the academic performance and participation of students with dyslexia in Zimbabwe have been noted to be declining (Nkomo, 2018). Brooks (2016) states that although good classroom teaching is the bedrock of effective practice, it does not enable children with significant literacy difficulties to catch up. These pupils need more resources, time and help than what the classroom can normally provide. Many dyslexic students have also been noted to drop out of school because the strategies implemented thus far are not sufficient to meet their developmental and educational needs (Nkomo, 2018). Therefore, implementing other measures to help boost the performance, morale, attitude and participation of dyslexic children is imperative.

Recent studies have concentrated on implementing Information and Communication Technology (ICT) in various fields of education to assist or enable the learning process. A mobile learning application that can facilitate the learning process of dyslexic students in primary schools is, therefore, of essence. A mobile learning application is a type of software application designed

for learners to use on a mobile device, such as a smartphone, tablet, or watch (Malanga & Banda, 2021). Some mobile applications can only be used with an active internet connection, while others don't require connectivity, and others can be used in either of the conditions. Smartphone penetration is on the rise in Zimbabwe, with a mobile penetration rate of 87.8% (POTRAZ, 2020). About 95% of Zimbabwean households have a cellphone, with 43% having phones with internet access (Moyo-Nyede & Ndoma, 2020). For the purposes of this study, we assume the use of smartphones with internet access.

Over the years, the practice of speaking countries' official languages, which is very common in Africa, caused native languages to be spoken minimally. This can result in forthcoming children having little to no knowledge of their languages, making them incapable of relating to the cultural heritage, which puts the language and its culture in danger, leading to extinction. However, the adoption of technology for language learning proves to be an essential tool in language skill development (reference). Linguists and Computer Scientists all over the world are working hand in hand to revitalise minority languages, resulting in numerous digital applications for language learning. This has resulted in various ICT-based technologies being utilised to support the preservation of minimally spoken languages. These include mobile apps, online dictionaries, virtual classrooms, and language games, which engage users in interactive and immersive language experiences. These technological innovations aid in language learning and foster a sense of pride and connection to cultural identity among speakers (Vatilifa et al., 2022).

Shona is the widely spoken language in Zimbabwe, with 80% of the population identifying it as their first language (Magwa, 2008). We can, therefore, estimate that 80% of Zimbabwe's dyslexic learners have Shona as their vernacular language. Research has shown that using the learner's native language as the medium of instruction helps a child develop their critical thinking and literacy skills, and it makes it easier to transfer their knowledge and skills across many different languages (Mulundu et al., 2021). Students learning in their mother tongue enjoy school more, actively participate, are more enthusiastic, have higher self-esteem, learn faster since they feel more comfortable in their environment and can easily transfer their knowledge to other languages as soon as they acquire adequate vocabulary in that language (Vatilifa et al., 2022). Therefore, the medium of communication for the Application is the Shona language.

Use of Mother Tongue as Medium of Instruction in Education

The mother tongue is the first language a person is exposed to in infancy and

learns to express themselves (Alweendo et al., 2021). In this study, this language is interchangeably used as mother tongue, home language, native language or first language. Over the past decades, researchers have investigated the significance and benefits of using the home language as the medium of instruction in schools. Most of the research established that learners with a strong mother-tongue foundation will more readily acquire strong literacy and linguistic abilities in the other languages, and they can easily transfer the knowledge and skills acquired in the mother tongue across all the other languages as soon as they acquire sufficient vocabulary (Benson, 2005; Cummins, 2000). It also helps learners to grasp vocabulary and concepts faster, thus making the whole education process more efficient and less tedious as they learn to read and understand skills quickly. Home language medium learning also promotes active participation as the learners understand what they are being taught and can easily relate to the questions they are asked. This makes them more enthusiastic about learning.

Several reports have indicated that learners acquire cognitive skills more readily in their first language (Chivhanga & Chimhenga, 2013; Kioko et al., 2014). Furthermore, learners exposed to home language medium learning often demonstrate better performance when their cognitive flexibility, creativity, analytical reasoning, mental flexibility and concept formation skills are tested (Preston & Lambert, 1969; Travers et al., 1993). Kioko et al. (2014) also established that it can help learners bridge the gap between home and school learning experiences. These learners also develop more confidence, and this promotes understanding and reasoning instead of just memorising what they are taught. This helps create a positive climate in the learning environment.

Primary school learners get frustrated and overwhelmed when a foreign medium of instruction is used, as they have to master the new language and simultaneously base their development of literacy and skills on this language. If regular learners face these many challenges with second language medium learning, the effects and difficulties are obviously worse on learners with language disorders. Dyslexic pupils already have difficulties understanding their home language, so teaching them in a language other than their home language and expecting them to understand the concepts simultaneously will simply be torture. Their first barrier is decoding what is being said, and after that, they have to understand what is being said, so adding another barrier in the form of language they are not familiar with is surely setting them up for failure.

Rello et al. (2012) found out that if a dyslexic learner is put under a test to determine the severity of their condition, the severity varies across languages. The study concluded that the use of complex languages makes it difficult for the

learners to comprehend what they are taught. The study also established that the condition is least severe when the participants take the test in their native languages. Therefore, there is overwhelming evidence that the mother tongue is very instrumental in a learner's development in education.

Past Research and Current Practices in Zimbabwe

Various studies have been carried out on how to help dyslexic pupils in Zimbabwe. However, these studies did not suggest or focus on technological solutions to the problem. An example is Nkomo (2018), who conducted a study to evaluate the intervention programs that are currently being implemented in Zimbabwe to facilitate the inclusion of learners in schools. The study discovered that inadequacy of policies, shortage of specialist teachers, negative attitudes from stakeholders and lack of relevant material sources were some of the factors affecting dyslexic learners in Zimbabwe. Nkomo suggested the development of dyslexia-friendly schools through designing relevant policies, training more expert teachers, and providing learning resources that cater to the diverse needs of dyslexic learners.

Some policies were implemented to guide the activities in mainstream and special needs education. One such policy is the Disabled Persons Act (1996), which states that pupils with disabilities should be provided with support services for their educational and social development. These policies led to the development and implementation of various intervention programmes for dyslexic learners across Zimbabwe. This includes the full and partial inclusion programmes. The full inclusion practice is one in which dyslexic pupils learn in mainstream classes with their non-disabled peers and are given access to the full curriculum (Armstrong et al., 2011). Partial inclusion entails teaching dyslexic pupils with the mainstream class for some activities and withdrawing them for some activities that require more demanding or specialised intervention (Gibby-Leversuch et al., 2021). However, Tafirei et al. (2013) argue that these methods only work for learners with mild dyslexic conditions.

Learners noted to have reading difficulties at infancy are mostly assisted through the Early Reading Initiative (ERI) (Nkomo, 2018). This programme is offered on a full inclusive basis, and it was adopted after researchers noticed a declining literacy rate and the need to offer intervention from Early Childhood Development (ECD). The other full inclusion programme is the Performance Lag Address Program (PLAP), which is meant for Grade 3 to 7 learners with reading difficulties. Learners who fail to benefit from these initiatives and intervention programmes are then put through whole school or clinical remediation. Regular class teachers conduct the Whole School Remedial Programme (WSRP) on

selected days per week. However, there are no definite structures set by the Ministry of Primary and Secondary Education to guide the administration of this program (Nkomo, 2018).

Mobile Applications for Dyslexic Learners

A mobile learning application is a software developed for sharing and accessing educational content or learning support materials while on the move (Park, 2011). Kukulska-Hulme and Traxler (2005) define mobile learning as a personalized, connected and interactive use of handheld computers in classrooms, collaborative learning during fieldwork, and counselling and guidance. Today's need for fast access to educational content and prompt communication has propelled this technology further.

Various mobile applications have been developed to cater for the needs of dyslexic individuals and the demand for these applications is increasing by each day. Rello et al. (2012) conducted a study and developed an Android-based eBook reader that displays eBooks in a way that is more accessible to dyslexic individuals. Their study found that many eBook readers for dyslexic individuals focus more on the design and layout but tend to overlook the accessibility aspect of the information in the books. Therefore, the Application remediates that by changing the text and content itself, for example, by using dyslexia friendly fonts.

EasyLexia is a mobile Android application developed by Skiada et al. (2014) to foster learning amongst dyslexic pupils and help them improve various important skills. During the development of the Application, they carried out research which established that dyslexic individuals prefer completing academic tasks and assessments on a mobile device and not on paper. Another application worth mentioning is Dyslexia Baca, which was developed to help learners recognize and distinguish every letter (Daud & Abas, 2013). The Application proved to be effective, as the users who had difficulties recognizing and differentiating some characters showed some improvement over time and eventually managed to recognise the characters without any difficulty.

Rahim et al. (2018) conducted a study and designed a mobile application for dyslexia in reading disorder problems that uses Malay as the medium of instruction. This study made many useful recommendations, some of which have been implemented by other developers and researchers in this field. For example, they proposed requirements and characteristics that can be integrated into the design of these mobile applications to make them more effective for dyslexic learners. An example of one of these requirements is introducing new words to dyslexic learners by substituting one alphabet with another, grouping

alphabets together, and using short stories in the Application. The research also highlighted many advantages of home language learning.

The Application that was developed for this research uses the multisensory teaching technique. The multisensory method of teaching is scientifically regarded as the most effective way for people with dyslexia to acquire information (Blomert & Froyen, 2010). Multisensory learning involves using two or more senses, usually auditory, visual and tactile, simultaneously to enhance language learning. This way, the learner can be able to associate the auditory (language we hear), visual (language we see), and tactile (language symbols we feel) pathways in learning to read and spell (Rahim et al., 2018). The dyslexic pupils use as many senses as possible in the Application, as they utilize the sense of sight to see animations, puzzles and text, listen to the audio using the sense of hearing and complete the jigsaw puzzles with the sense of touch.

The existing applications focus mostly on the phonics and phonological sounds of the alphabet. Therefore, these applications only engage two senses simultaneously. Research has shown that the more the senses are engaged, the more effective the teaching process and the better the knowledge retention (Blomert & Froyen, 2010). The existing applications are also in English and various other languages, and none has ever been developed in Shona. This challenges dyslexic learners, as it is harder for them to understand the concepts in a foreign and complicated language. Furthermore, none of the applications use jigsaw puzzles as a means of teaching language, as is the case with the Application that was developed as part of this study.

Research Methodology

This research adopted the Design Science Research Methodology (DSRM) to design and develop a Mobile Application Solution to teach the Shona language's orthography, grammar, and phonology to dyslexic learners in Zimbabwe. The DSRM provides a framework with a defined rigorous process that enables researchers to create and evaluate technological artefacts to solve identified organisational or societal problems (Peffers et al., 2007). It consists of the following six steps, which are shown in Figure 1 below: (1) problem identification and motivation; (2) definition of objectives for a solution; (3) design and development; (4) demonstration; (5) evaluation; and (6) communication.

Step 1: Problem Identification and Motivation

The first step for the research was to identify the problem, which, as discussed in Section 1, is the inadequacy of existing intervention programmes for dyslexia learners. Therefore, the research was conducted to explore the benefits

of integrating assistive technological solutions with existing intervention programmes in order to help Shona-speaking children with dyslexia improve their fundamental skills. The population was comprised of parents of dyslexic learners and special needs teachers from primary schools in Zimbabwe.

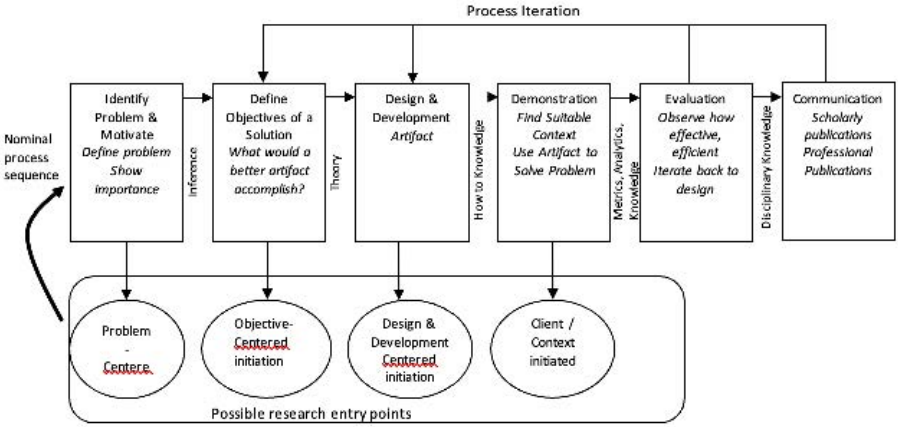


Figure 1: The Design Science Research Methodology (Adapted from Peffers et al. (2007)) section discusses the research methodology used for the study

Step 2: Define the Objectives for a Solution

The second activity is to define the objectives of the research. The main objective of this research was to design and develop a mobile learning application to help dyslexic learners with reading in Shona. The second objective was to identify the requirements of a Shona mobile learning application. The third objective was to identify and integrate content suitable for dyslexic learners, and the final objective was to develop the prototype, test it, and finally deploy the Application.

To meet the requirements of the second objective, the following sampling techniques were used:

A. Dyslexic pupils were identified and selected to participate in this study. Consent of learners' participation was obtained from their parents. In addition, the parents of dyslexic pupils who participated in the study were selected randomly using convenience sampling to participate in a survey used to determine the system requirements. In total, 17 respondents took part.

B. Purposive sampling technique was used to select teachers to participate in interviews. Researchers intentionally selected teachers who are knowledgeable about the study area using purposive sampling. Three special needs teachers with five or more years of experience were selected from mainstream schools.

Research Instruments

Interviews, survey questionnaires and documentary analysis were used to collect data for the purposes of this study. An interview is a process where the researcher and participant have a conversation on questions related to the research study that was conducted, and responses are recorded and analysed (Dilshad & Latif, 2013). Interviews were done to collect qualitative data. Questionnaires were distributed to collect quantitative data. Finally, document analysis was done to examine documents related to dyslexia and extra supporting information.

Data Collection Procedure

The study made use of the online survey platform Survey using Google Forms. Links for the questionnaires were distributed on Facebook and Quora, targeting Zimbabwean communities and support groups of parents with dyslexic kids. Interviews were then carried out between the researchers and the special needs teachers for in-depth data generation, conducted via Zoom. Documentary analysis was used to gather information from research documents on dyslexia application development-related studies. All these procedures facilitated the requirements collection process.

Data Analysis

Quantitative data was analysed using descriptive statistics, Google Forms and Microsoft Excel. Google Forms was used because it is a free tool that aggregates and analyses responses from users and presents the results in a simple online interface. It is easier to prepare and disseminate compared to traditional surveys prepared using Microsoft Word. The results can then be viewed online or exported to a spreadsheet. Further analysis of the spreadsheet was done in Excel since Google Forms has some limitations, e.g., if two users provide the same short answer, one starting the answer with a capital letter and the other with a small letter, it records the answers as two different answers in the graph or pie chart. Qualitative data was analysed thematically.

Step 3: Design and Development

The first activity was to design and develop the artefact as described below:

Architectural Design

The Model-View-Presenter (MVP) design pattern was used for the application's architectural design. The MVP pattern makes code reusability and testability easier. This pattern divides the Application into three major layers. The first layer, which is the view layer, is responsible for displaying data (model) and routing user input and commands to the presenter layer. The view layer does not contain any logic. When a user clicks on a specific puzzle, for instance, the view layer is responsible for routing the request for that puzzle to the presenter layer. The presenter layer, which is the second layer, will receive the request from the view layer and retrieve the puzzle from the third layer, which is the model. The model is an interface that contains the data that will be displayed on the view. The presenter acts upon both layers, receiving requests from the view, retrieving data from the model and formatting the display on the view.

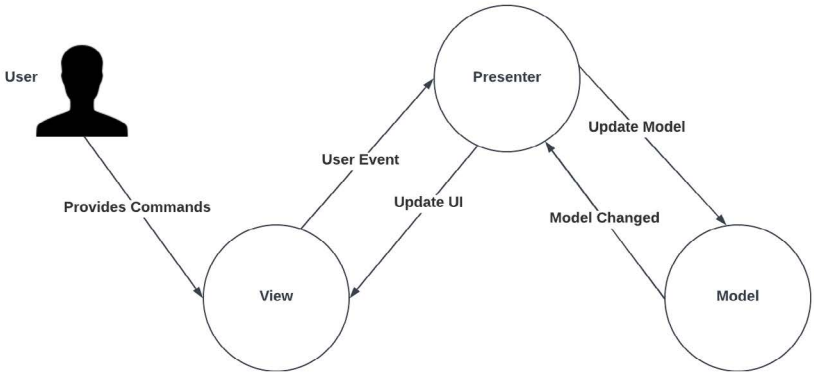


Figure 2. Model-View-Presenter Design Pattern

Flowchart

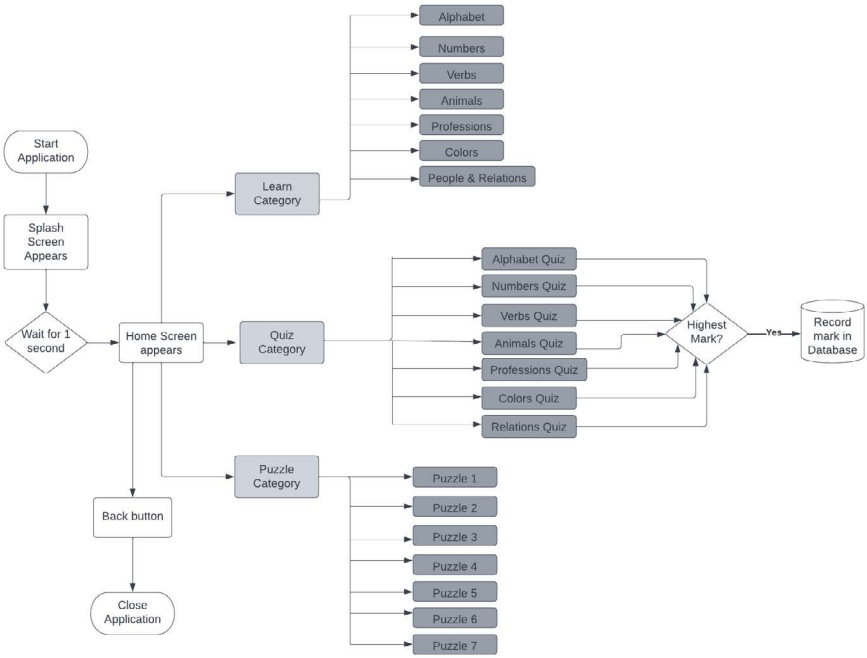


Figure 3. Flow Diagram

Step 4: Demonstration

The following section demonstrates how the application functions.

Home Screen

The home screen serves as the gateway to the different categories. From the home screen, the user can navigate to three different categories. The first category is the learn category (dzidziso), followed by the quiz category (mibvunzo) and puzzle category (tsoro). An image that illustrates the titles of each category was added to each card view to help students conjoin the given titles to the referred images. The interface was made as simple as possible for the learners to be able to navigate with little to no guidance, and the colours used cater for the user needs of dyslexic learners.

Figure 4. Home Screen

Learn Categories Interface

The learn category interface helps the user navigate to seven different learning sub-categories. These sub-categories are the alphabet (arufabheti), numbers (nhamba), verbs (chiito), animals (mhuka), professions (mabasa), colours (ruvara) and relations (hukama). Once again, each sub-category has an illustration of the title. A card view, a recycler view and an adapter view were used for the design of this interface.

Figure 5. Learn Categories Interface

Alphabet Interface

A click of the alphabet card leads the user to the alphabet interface. The layout of the interface is specifically designed for children with reading difficulties; therefore, it has a minimum amount of text to avoid overwhelming the dyslexic learners with information and large blank areas in order to encourage a good reading flow and pace The button produces the phonetic or audio sound when clicked and directly above it are the phonics of the Shona alphabet. The letters of the alphabet were displayed as 3D (three-dimensional) rotational animations since dyslexic individuals are most likely to visualise characters in 3D. These interfaces support multisensory learning, as the user uses their sense of sight to view the various elements displayed, their sense of touch to play the audio of the sound over and over again, and their sense of hearing to listen to the audio. When the directional arrow buttons are pressed, the next or previous character in the alphabet is displayed.

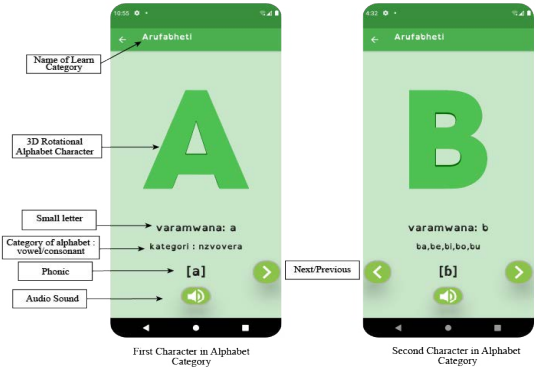


Figure 6. Alphabet Interface

Numbers, Verbs, Animals, Colours, Professions and Relations Interfaces

The other options include numbers, verbs, animals, professions, and relational interfaces. The same design and user requirement considerations were applied to the alphabet section throughout all the sections. Animations illustrating the text were used across all the sections for users to associate the text with the corresponding animation, for example, under the verb sub-categories, animations demonstrate the action. All this was done while at the same time ensuring that no additional user interface complexity was introduced.

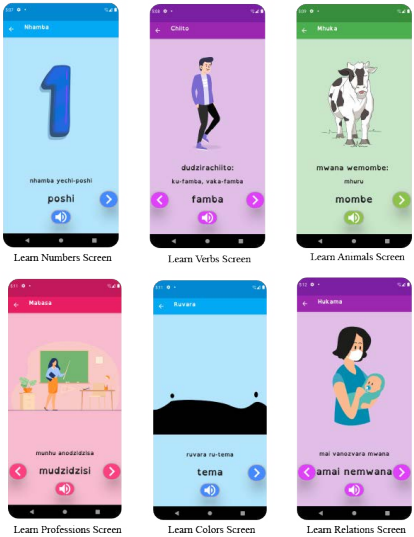


Figure 7. Learn Interfaces

Quiz Category Interface

The quiz category interface helps the user navigate seven quiz sub-categories. The quiz categories correspond with each category in the learn categories, assessing the knowledge gained under each section in the learn category. Three types of information are displayed on each card: the image to illustrate the title and a question mark to symbolise the questions that are to be asked, the title and the highest mark record (maki hombesa) on each quiz category for tracking progress. When a user scores a new high mark, the mark on the card is updated.

Figure 8. Quiz Category Interface

Verb Quiz Interface

On the click of the verb card, the verb quiz interface opens. The information diplayed on this screen are: question number (mubvunzo) at the top which increases and shows you how many questions you have done, the score (zvibodzwa) where you can see your credit as the quiz progresses, the animation to illustrate the particular verb and one correct answer and two random false answers. The quiz questions are random to ensure that the quizzes do not become boring and monotonous. When an answer is selected, an audio output notifies the pupil whether they got it right or wrong, but never using discouraging words, and automatically moves on to the next question.

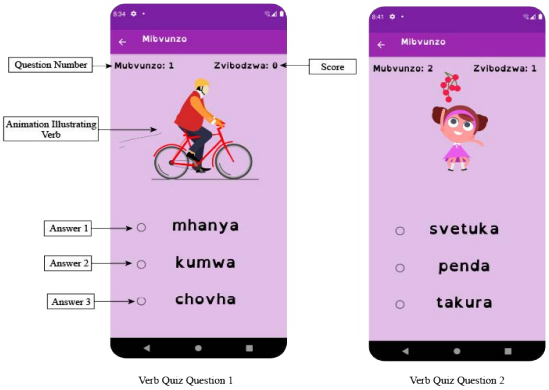


Figure 9. Verb Quiz Interface

Alphabet, Numbers, Animals, Colours, Professions And Relations Quiz Interfaces

All the quiz categories share the same interface as that of the verb quiz interface explained in the previous section.

Figure 10. Quiz Interfaces

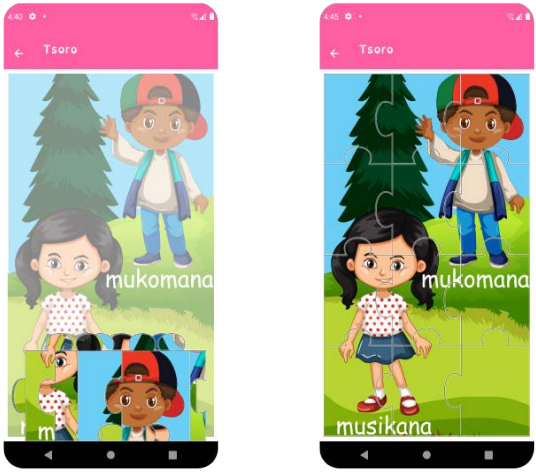
Puzzle Selection Interface

When the puzzle card is clicked on the main menu screen, it opens this screen. The user can choose which jigsaw puzzle they want to complete from a total of 7 puzzles. The puzzles were designed in Adobe Illustrator. They are consistent with the rest of the Application, as the images are an extension of the learn category. The jigsaw puzzles feature relations, animals and professions.

Figure 11. Puzzle Selection Interfaces

Puzzle Interface

When a puzzle is selected, this screen is opened. The user completes the jigsaw puzzle by dragging the pieces at the bottom of the screen and dropping them in the correct position. Once a piece is in the correct position, the user cannot move it anymore. A pale background was used to provide contrast between the puzzle pieces and where to place them. The Application was developed based on the understanding of dyslexia's nature and how it affects learning, not only in the writing and reading process, but also in problem-solving, i.e., children must recognise and identify visual shapes and objects to choose them. This problem-solving facilitates reading as nouns in every puzzle help the learner identify the items or things in the puzzle. The jigsaw puzzles implement multisensory learning as the user uses the sense of sight to read and analyse the puzzle pieces and text, while at the same time using the sense of touch to move around the pieces. This will also help improve the pupil's hand-eye coordination.



Puzzle at Start Puzzle at Finish

Figure 12. Puzzle Interface

Step 5: evaluation

The system that was developed remediates the effects of dyslexia by teaching students to read using the multisensory technique. The system has a learn category that has seven different sub-categories, a quiz category that assesses the knowledge gained from the learn category and a jigsaw puzzle to help with

problem-solving and visual-motor integration skills. In addition, 88.2% of the parents confirmed that this application would be mostly beneficial, while the teachers who were interviewed shared the same sentiments. Furthermore, 94.1% of the parents and all the teachers agreed that learning in Shona will benefit the pupils. The following is a list of sub-objectives that were set at the inception of this project and how they were achieved:

Objective 1: To identify the requirements of a Shona mobile learning application.

Various information regarding the requirements of such an application was gathered through interviews with three experienced special needs teachers, a survey with 17 participants who are all parents of Shona-speaking dyslexic pupils in primary school and documentary analysis. These requirements were divided into functional and non-functional requirements and guided the application development and integration of various features.

Objective 2: To identify and integrate content suitable for dyslexic learners

Throughout the 3 interviews with experienced special needs teachers, stakeholder feedback and documentary analysis, the research managed to establish the content that is best suitable for dyslexic learners and how to display it in a way that is accessible to the user needs of dyslexic pupils. The content developed allowed for multisensory learning, was interactive and engaging, and informative, while at the same time not overwhelming to the students.

Objective 3: Design and development of the Mobile Application

Prototypes of the system were developed with frequent iterations. Over the lifecycle of the project, three prototypes were developed. After each prototype, stakeholders were involved to ensure that all the user requirements were met.

Objective 4: Testing and deploying the Application

The application went through various stages of testing. The different tests were unit, integration, system and acceptance testing. The application was installed on 10 different Android smartphones owned by dyslexic pupils. Usability was evaluated using the generic usability attributes: learnability, efficiency, user satisfaction, effectiveness, simplicity and comprehensibility. On-site evaluation was not possible as the researcher was not based in Zimbabwe, so the evaluations are largely based on user feedback. The parents of the dyslexic pupils noted how the students did not need any guidance while going through the Application and how easily they understood the functionality of each button and component, amongst other things.

Results

The researcher conducted a survey, and the results were analysed using Google Survey and Microsoft Excel. A total of 17 parents with dyslexic children answered the questionnaire. The ages of the children were distributed from five to twelve. The research established that every parent in our sample was a parent of a primary school-age pupil**.** 100% of the respondents indicated that their kids are indeed enrolled at a school. In addition, all 17 (100%) of the respondents stated that their children have a reading problem. These are the learners that the application targets, and there is a justifiable cause for developing an application that solves the issue.

A question was asked to establish whether phonological processing is the most prevalent type of dyslexia, as was mentioned earlier in this research, and this proved to be the case. This question helped this research establish that the same challenges persist throughout these pupils' primary school phase. The reading problem is common across various age ranges, from the kids who have just joined the primary schooling system to the kids who are about to leave and join the secondary school system. 70.6% of the pupils were identified to have a writing problem, while 11.8% had a speaking problem.

A follow-up question was asked, whether the children were part of any intervention program. 94.1% of the respondents confirmed that their children were part of intervention programs, while 5.9% gave a negative response. The results from the previous question established that all the students have a reading problem. Afterwards, a question was asked whether any improvements were noticed in the children's performance after they were introduced to intervention programs. 50% of the respondents stated that they had noticed some improvements in their children's academic performances, whilst the other 25% stated that they had not, and the other 25% were unsure. This further explains why there is a need for integrating other solutions with the current intervention programs, because clearly, they are not as effective.

Most importantly, 75% of the participants own Android smartphones readily available for their use, which justified choosing the Android OS. The Android application will reach a much wider audience than any other mobile OS the researcher might have selected. 25% of the respondents use iOS.

Interview Results

In addition to the survey, the researcher conducted interviews with three teachers with more than five years' experience teaching special needs learners to design effective learning materials for dyslexic pupils. All this was done with

the objectives in mind to gather as much information through real experiences among teachers that can be used as input in designing the learning materials for dyslexia with reading disorder problems. The interviews were conducted via Zoom. The interview questions are mentioned below, along with the responses and a brief analysis.

1. **Does your school use assistive technological solutions or mobile learning platforms to teach dyslexic pupils?**

   All the respondents said they do not. This shows that assistive technological solutions have not yet been given a chance to alleviate the effects of dyslexia in the Zimbabwean intervention programs.

2. **Which areas do your dyslexic pupils mostly find challenging?**

   All three teachers agreed that reading was a challenge, with the other two mentioning that writing and speaking were also difficult for the learners. This proves that reading is the most challenging task for all dyslexics, and by tackling it first, most of the problems dyslexic learners face might be solved.

3. **Do you think learning in Shona would benefit the kids, and please provide a reason for your answer**?

   All three confirmed that they think it is beneficial. The first interviewee stated that it is so because the pupils enjoy learning more in their mother tongue, the second respondent mentioned that the kids are more confident and participatory when using Shona, while the third respondent mentioned that the learners fully grasp the concepts when taught in Shona. This justifies why Shona was used as the medium of instruction in the application.

4. **Would a mobile learning application to facilitate reading amongst dyslexic learners be useful?**

   All of the interviewees gave an affirmative response. This justifies why this application is of the essence.

5. **Can you please suggest additional things that would make the application effective in helping dyslexic learners to read?**

   First respondent stated the use of text and audio, and integration of interactive and engaging content. The second respondent mentioned offering a variety of choices for acquiring knowledge and the use of dyslexia-friendly colours and fonts. The third respondent mentioned providing information in small doses, text-to-speech and engaging content.

All the suggestions were integrated into the Dyslexia Help in the Shona application.

Conclusion

In conclusion, this research paper primarily focused on the development of a mobile learning application that facilitates reading amongst dyslexic learners in Shona. The Application was successfully developed, and all the objectives were met in the process. The stakeholders gave satisfactory feedback after using the Application.

A survey, interviews and literature review highlighted other research done internationally and locally to remediate the effects of dyslexia. The findings from the interviews showed that no technological solutions have been implemented thus far in Zimbabwean schools to solve this issue. From the analysis of the survey and interviews, it was clear that the current education system has some shortcomings. The survey also indicated that the kids were using assistive technological solutions at home, but these solutions posed various challenges. These challenges were addressed in the development of the Dyslexia Help in Shona mobile learning application. The App was deployed on Google Play and is available as DysShona. This scholarly publication constitutes the last step of the DSRM, Communication.

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