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## Mobile game-based learning system for a local language

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**Abstract:** The problem of language endangerment as a result of deficiency among the Bassa natives of Liberia and the prevention of the extinction threat posed on the language motivates the need to explore the use of game-based learning system for its resolution. A bilingual Electronic Dictionary (ED) for automatic translation of English text to equivalent Bassa language text alongside its corresponding audio pronunciation on an Android-based mobile device was developed. The system was designed using the Unified Modelling Language (UML) tools and implemented using the Java programming language in Android studio environment. The system was evaluated using Mean Opinion Score (MOS). Result of evaluation shows that age is directly proportional to the knowledge of Bassa language in Liberia. It was evident that the elderly Bassa natives have better knowledge of the language while the younger ones have less or do not understand at all. The mobile application software developed in this work will aid youth learner of the Bassa language.

**Keywords:** digital game-based learning; language teaching; Bassa language; games; motivation; information communication technology; mobile learning; mobile applications.

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## **1 Introduction**

The language of the people is an integral part of their lives because it synchronises with their identity, culture and environment. Language is an essential foundation of culture. Language impacts the daily lives of the human race, creed, and region of the world. It is the natural and most powerful means to convey or express our feelings, desires and queries to the world around us. Words, gestures and tone are employed in the union to reveal a broad spectrum of emotion. The only channel by which human beings' abstract reality is by language (De Valoes, 2014). Language (written and spoken) is a unique and diverse system used by human beings for communication. It is a large part of our innate ability to form lasting bonds with one another, separating humankind from the rest of the animal kingdom. Language is an efficient and effective medium of communication, which explicitly represents the ideas and expressions of the human mind (Abiola et al., 2014). It is more than an instrument for the conveying of ideas. With all this attributed importance of language as a reservoir of all aspect of culture, indigenous languages are still most times neglected in all ways (Amfani, 2009). Consequently, indigenous languages have continued to play second fiddle while the English language has taken the number one position in many countries. Therefore, the use of English language, globalisation and civilisation should be an asset and a means of communication to other parts of the world but should not bring about the endangerment to other indigenous languages.

Information and Communication Technology (ICT) could be harnessed to propagate the indigenous languages (Osunade et al., 2015). Although, indigenous language loss and revival is not a new topic of interest in academic research or new area of community activism, however, less attention has been paid to indigenous languages. For instance, in recent years, in a country like Liberia, the means by which the new media or digital technologies could be used to support the learning, teaching and renewing of endangered languages has not been sufficiently explored (Grenoble and Whaley 2006). Bassa is a tonal language, the second largest indigenous language in Liberia (13.4%) after the Kpelleh language (20.3%), (CIA-Factbook, 2008).

In addition, the study of indigenous language revival points to the importance of local control and community decision making. Indeed, facts from around the world revealed that successful language renaissances are entrenched in the community initiative and investment (Eisenlohr, 2004). Lack of this indigenous resourcefulness has gravely endangered Bassa language and it is considered to be going into extinction. Consequently, most adults, youths, and children can speak the language, but cannot write in the language. The ones who can speak as well as write in the language are the few elderly ones (Shaffer, 2011). Documents written in Bassa language are available in religious books. This work aims to build a global platform as well as a digital language learning resource that will motivate the Bassa speakers and learners to learn the language adventurously hence encouraging them to speak and write in the language. This will serve as a resource for teachers of the language and help the students obtain improved academic performance in the language.

Mobile technology has paved the way for language learning. In recent year, mobile technology has been the mainstream where language learner obtains instant help on word's definition and pronunciation. As the number of mobile device users increase from day-to-day, developing mobile dictionary applications for effective learning of the second largest spoken language in Liberia will provide a learning tool to promote nationalism and cultural revival. The digital game-based language learning application on Bassa language would motivate learner to learn Bassa. Language learning therefore requires motivation (Gamlo, 2019) without motivation even the brightest learners might become unable to achieve the language proficiency.

Game-based learning incorporates educational content into digital game that can increase learners' inner learning motivation (Chang and Hwang, 2019) and thereby improve learning processes. Improving students' performance especially in web programming course motivated Zaibon et al, (2018) to develop a digital educational comic as a teaching tool for the subject. Similarly, the application developed in this research is expected to close the wide gap between the indigenous and the official language and provide a digital language resource for the Bassa language learners.

Bassa is found across Africa in countries such as Sierra Leone, Ivory Coast, Liberia (Olukoju, 2006) Brazil and the Caribbean. Liberia has the highest population of this language group, they are domiciled in Margibi: coastal areas and Gibi district inland, Grand Bassa, Montserrado and Rivercess counties (Olson, 1996). Bassa remains the largest in Monrovia, the Liberia's capital city (Levy and Spilling, 2008). Bassa belongs to the Niger-Congo, Atlantic-Congo, Volta-Congo, Kru and Western Bassa language families. Central Bassa is the standard Bassa in Liberia. The Bassa alphabet phonology has thirty letters comprising 23 consonants and 7 vowels. The Bassa Vah script is the writing system of Liberia, Sierra Leone, and Bassa speakers in Brazil and the Caribbean.

Diacritics are referred to as accents, which can be written as dependent symbol upon another symbol; that is, a symbol that does not occur independently, but always occurs with and visually positioned in relation to another character, usually above or below. In the case of the Bassa language diacritics, symbols must be above the vowel glyph. Bassa has no under-dot diacritic mark. Glyph referred to a shape that clearly represents a character. It is a graphic object stored within a font. Glyphs are objects that are recognisably related to particular characters and which are dependent on particular design. Tone (diacritic marks) in Bassa indicate the tone of the vowel. These marks are

positioned on the exterior above the vowel glyph; the diacritic marks are the upper accents, which in Bassa includes the high, low, mid, contour, straight line/long and nasal (optional) vowel.

The pronunciation of words in Bassa language is tonal with five distinct tones: high ( ´ ), low ( ` ), mid ( ˘ ), contour ( ˇ ), straight line/long ( – ) and nasal ( ~ ) (optional) vowel. The High tone slants downward from right to left, for example: I (M̄), see (dyé), ocean (dyóó). The Low tone is indicated by a slash which slants downward from left to right, for Example: you (M̄), bring (dyà). The Mid tone is signified by the absence of a diacritic tone mark over the vowel. For example: dance (Dye), carry (kpa). The Contour tone is a combination of a low tone plus a high tone over a single vowel. Contour is indicated by two slashes which slant downward from left to right and from right to left. For example: father (bã), knife (dã). The Straight line/long occurs above vowels of only four Bassa words. Example: wow (kē), I (mō), just (pū), so/this way/here (nō). Nasalisation is a wavy line above a vowel signifying that the vowel is to be nasalised, for example: rat trap (Kĕ), shine (fã). However, the nasal is not used above the vowels ‘o’ and ‘e’ in the Bassa Language.

Electronic dictionary of several world languages is presently available in almost all mobile devices and are, actually used as a digital language, learning tool that enables the device users get instant access to the resource. However, until date, none exists for any of the Liberian languages. Liberia is a multilingual country with English being the official language of communication and formal education. This has therefore posed a threat on the survival of her indigenous languages. It is crucial that all the languages receive appropriate attention thereby promoting and empowering them to, better serve the speakers. Essential aspects of the life of a people are encoded and expressed in its language. Hence, integrating an electronic game device of English and Bassa language would provide indigenous speakers and learners (beginners) the opportunities to develop and diversify linguistic domain as well as global platform for the language. This research is essential for the following:

- 1 Promoting a better understanding and recognition of the Bassa language
- 2 Preserving and preventing the Bassa Language from going into extinction
- 3 Assisting in promoting indigenous language as a historical part of Liberia’s cultural heritage and enhancing students’ academic performance in the language;
- 4 Helping the indigenes to close the gap between the indigenous and the official language.

In view of the present problem and the significance of the development of an assisting device, this research work seeks to answer the following questions:

- 1 What is the level of understanding of Bassa language among various ages of the indigenes?
- 2 What is the relationship between this level of understanding and various language domains?
- 3 How can a game-based learning system be employed to support teaching and learning the language?
- 4 How can a local language be preserved and rescued from extinction?

## 2 Literature review

Technology has evolved and, continues to flourish as a significant tool for supporting language learning. Mobile Assistant Language Learning (MALL) is a successor of all the technology-learning facilities and, there is already a lot of research springing up on this topic. As mobile devices become more powerful, affordable, user friendly, the research of mobile-assisted language learning becomes a necessity. Mobile devices include smartphones, palmtops, PDAs, tablet PCs, laptop computers and personal media players. The most simple and user-friendly resource currently is the mobile phone. The progress in the technological development has aspired an upswing in the availability of educational apps, most of which are free, hence the need for educators to support learning with technology, especially the MALL. The use of MALL enable students to read, listen and communicate with their peers and teachers, at any time, outside the class. Hung et al. (2018) presented the diverse nature of this field and suggests the overall feasibility of using digital games for promoting the language and literacy learning of both native and non-native speakers in various aspects. A review of previous works on different electronic learning systems including the monolingual, bilingual, and multilingual dictionaries for different languages, game-based language learning as well as Machine Translation systems, are presented in the following sections.

### 2.1 Dictionary tools

Monolingual Electronic Dictionary (ED) use similar language to define a word. It defines a word in a different and explained form using the same language as the one used to write the word so that the user can clearly understand the different meanings and uses the word has in that same language. These kinds of electronic dictionary are the easiest to construct, as there is no need of translation to another language and hence requires less memory space Bilingual and monolingual dictionaries are the most used dictionaries by the language learner (Deksne et al., 2013). In general, most language learners (beginners) prefer to use bilingual dictionaries because they bring instant satisfaction, while teachers prefer monolinguals for their long-term benefits. Bilingual dictionaries are, generally employed in the initial stages of learning a language. They use another language (target) to define a word of the source language. When the translation of the word is given in more than one language, the dictionary is termed a multilingual dictionary. Multilingual electronic dictionaries often include a database of cross-referenced unilingual dictionaries with the use of pivotal language or other multilingual techniques such as ontology.

A multimedia multilingual dictionary for Nigerian Indigenous Languages (Yoruba, Hausa and Igbo), was developed by Olorunlome (2016). The study employed interview methods to collect data from language experts. Microphone and a digital camera were used to collect audio and video data. The software was further developed for Microsoft Windows and for other operating system. The model for the multimedia multilingual dictionary was designed using the Unified Modelling and implemented using the Python programming language version 2.7 while Hash table tool was used to construct the system database. The result obtained from the research showed that the development of interactive multimedia had a great positive impact on the community of users. It helps with the visual display of objects in facilitating language learning. The author presented the importance of indigenous languages as a cultural heritage. The benefits achieved from this study revealed that the electronic dictionary help in

promoting the level of knowledge and skills in an African language. Moreover, the study addressed the need to document the cultural heritage and provides indigenous speakers or learners the opportunities to develop distinct linguistic domain.

Zelalem (2010) developed a novel multilingual and multidirectional ED for Ethiopian languages (Amharic, Afaan Oromo and Tigrigna) using the Object-Oriented model, Android Software Development Kit (SDK) 2.0.1, Android Virtual Device (AVD), Eclipse Java Integrated Development Environment (IDE), and Java Development Kit (JDK). The model was designed using Unified Modelling Language (UML) and implemented using Java programming language. The result obtained from the developed system showed that the application user can input English text and get output translation in three Ethiopian languages. However, the developed system cannot play the pronunciations for the words' meaning through audio sound. The work facilitated the smooth information exchange among people of the country and enhanced the bond between the local languages and the current communication technology. It also showed that ED could be of great help for language learners, international organisation workers, tourists, investors, researchers in understanding and communicating easily with the native speakers of the languages. The software obtained from the research was further developed for smartphones with Android operating system.

Akinwale et al. (2015) presented a web-based user-friendly English to Yoruba Machine Translation system. The research work employed rule-based method and twenty-two rules were formulated for the translation, which is specified using context free grammar. A bilingual dictionary dataset containing English words and the corresponding translation in the Yoruba language was used. The system was implemented using Hypertext Markup Language (HTML), Visual Studio 2012, ASP.net and C-Sharp programming languages. The study addressed the importance of globalising the indigenous language as it promotes the language and prevents it from going into extinction. The work further showed the effectiveness of the mother tongue for instructive purposes. The result obtained from the study showed that English word can be easily translated into Yoruba words.

Tan and Atienza (2014) worked on Librorum: A Crowdsourcing Filipino-English Dictionary Mobile Application. The work employed crowdsourcing strategies which help the content of the dictionary to be contemporary and accurate. The study revealed that crowdsourcing data strategy has been successfully implemented in Wikipedia and StackOverflow, and the result of their findings matched the targeted user and professionals in a classroom-like experience for the users to interact, observing a crowdsourcing standard to connect public users with experts. The software was further developed for iOS mobile devices specifically for iPhones with offline support using the native iOS SDK and mobile SQLite database. The system allowed the dynamic update of Filipino-to-English dictionary database. The study focused on four major issues faced with the current Filipino-to-English dictionaries that is they are not contemporary, not dynamically updated, and do not provide definitions with correct usage, and there is a lack of interaction between the user and the application. The result further showed the effectiveness of crowdsourcing for scheme wherein the users protect their profile with reputation points and complete tasks as granular as possible. The result from the research could be used as a useful reference source for children learning both English and Filipino and to foreigners traveling to the Philippines.

A Speech-based Dictionary Application, which considered WordNet 2.0 lexical database for the reference database and information retrieval was developed by Lerlerdthaiyanupap (2008). VoiceXML with Microsoft English (U.S.) V6.1 Recogniser was used for the user input, DictService Web Service, ACME Server, Apache Axis2 were used for the development environment and Java programming language for the system implementation. This work focused on the construction of Speech-based dictionary application, which combined speech technologies such as Speech Recognition, Text-to-Speech Synthesis, and Dialogue Manager integrated with electronic dictionary. Windows Desktop, Client-Server application was developed. The application allowed user to input words or phrase using the speech interface and then listen to the output definition. It does not provide a definition or translation in another language. The targeted user of the resulting application from the research are the elderly and non-natives speakers who have an average speaking and listening skills with a strong accent.

Li et al. (2010) worked on the Development of Dictionary Tools on Window Mobile Platform. The mobile dictionary system was developed using Visual Studio 2005, Visual C-Sharp, .NET Compact Framework 2.0, Windows Mobile 5.0 Pocket Personal Computer (PC) Software Development Kit (SDK), Windows Mobile 5.0 Emulator Images for Pocket PC, ActiveSync 4.5, and the database was constructed using Microsoft Structural Query Language (SQL) Server 2005 Mobile Edition. This work focused on the bilingual (bi-directional) mobile dictionary, which provides words meaning from Chinese to English and vice-versa. The developed system allowed a user to input Chinese words and it automatically matches and shows all the related English words in the thesaurus. Users can also select the words, and the system automatically shows the Chinese explanation in details. Similarly, the system supports a user-defined functions of add and delete contents. The system contains two parts: the system and user thesaurus. System Thesaurus is attached to the program installation, and it does not allow the deletion of the word. User thesaurus is constituted by the words that users add, and it allows the deletion of the word. Thus, it allowed users to add new Chinese words and their corresponding meaning in English.

Eludiora (2014) investigated and presented a report on the development of an English to Yoruba Machine Translation. English and its Yoruba equivalence text data were collected, the model was designed using Unified Modeling Language (UML) and Flowchart. The software developed from the research was implemented using Python programming language. The result obtained showed that the system allowed entering of simple sentence in English and displays Yoruba corresponding text. The author employed context free re-write rule, parse tree, automata theory and lexical corpus construction techniques. The result obtained shows that context free re-write rules, parse tree, automata theory and lexical corpus construction techniques are useful for English to Yoruba translation. The result also showed that the system could be useful for language (learner) beginners who are ready to learn the Yoruba language.

## *2.2 Game-based learning tools*

Ninan et al. (2019) stressed that a mobile game-based learning enhances the learning interest of learners and increases their learning motivation owing to the fact that the difficult subject can be learned with fun. The mobile game-based learning system

(FÀMÌSÌ) which combines gamifying with the process of learning Yoruba diacritics insertion will motivate the teachers and sustain pupils' interest in learning the subject. Yoruba text was gathered using interview and internet sources. The system was designed and implemented using the unified modelling language and JavaScript framework, ReactNative applications for iOS and Android. It was reported that the game raises the players' attention, enhances their memory and the players learn new knowledge that can be used in other aspects of life.

Development of a Mahjong-like word spelling game which can engage the learners to effectively understand and memorise English vocabularies was reported by Tsai et al. (2016). The design was a multi-party game, which combines English spelling and Mahjong game for improving the ability of vocabulary spelling. It allows interaction among multiple learners playing the spelling game together. The result of this work as reported stimulates and enhances the learners learning effects through gaming competition among learning peers.

A Competence Performance Analyser (CPA) tool that keeps trace of the players' activity in the shape of events in the game and, based on these activities, assesses related performance with respect to a predefined set of competences was reported by Parodi et al. (2014). The Game traces the learners' behaviour as they play and provides data to a dedicated software module called CPA which elaborates the information and assesses the performance. The CPA hence used the raw data to calculate the performance indicators and in turn used the result to assess performances respect to competencies.

Ninan et al. (2017) developed a mobile learning platform for Yoruba language speakers and learners. The study employed an on-site interaction method in gathering text data from native speakers in four common domains (Market, Hospital, Motor-Park and Restaurant). The system was implemented in Android Studio and PRAAT software was used for the recording of the Yoruba phoneset. The work developed an Android operating system based application software for mobile phones or handled devices. The outcome of the study provided a simple, effective and efficient way of communicating in the Yoruba language between tourists and indigenes of the country. The development of this system aimed at assisting the targeted users (tourist) to learn and understand basic words in order to interact with native speakers of the language.

Sung and Hwang (2013) reported a collaborative game-based learning environment which was developed by integrating a grid-based Mindtool to facilitate the students to share and organise what they have learned during the game playing process. The study seeks to find whether the students who learn with the developed game-based learning approach show better learning achievement, attitudes, motivation and higher efficacy of group learning than those who do not learn with the approach. The result showed that the proposed game-based learning approach has shown significant effectiveness in improving the students' attitudes, motivation as well as learning performance.

Zou et al. (2019) reported the review of a considerable section of research studies which have been conducted on Digital Game-Based Vocabulary Learning (DGVL) from the education dimension. The result of this work established the positive effects of games in supporting vocabulary learning as well as facilitating reading, listening comprehension and pronunciation improvement. Hung et al. (2018) carried out a review on educational digital games with the aim of identifying critical gaps and opportunities in domain-



specific areas. It was reported that 45 of the 50 (90%) educational digital games selected for the study facilitate language learning. The author reported a growing trend of utilising mobile devices for delivering games and a shift in the research focus to Mobile Assisted Language Learning (MALL) compared to previous works where PCs were the most common platforms for delivery of games. The work reported the existence of a wide variety of digital games in practice for language learning. However currently, very few of these tools exist for African languages in general and until date, none exists for Bassa language in particular.

### 3 Methodology

Text data of home domain terminologies was collected from Bassa indigenes who are the native speakers of the language. Audacity®, an open source, cross-platform audio software was used for recording and editing the audio of the collected data. Unified Modelling Language (UML) was used to design the Bilingual Electronic Dictionary learning system for the Bassa Language. The system was implemented using Java in Android Studio environment. The implemented system was tested and validated using Mean Opinion Score (MOS).

#### 3.1 Participants

In the MOS evaluation, there were Fifty-seven (57) respondents; 25 were females and 32 males. Table 1 shows the demographic profiles of respondents. Table 1 shows the respondents age range, gender, educational level and average score per age groups. Four (4) of the participants possessed Vocational School certificate, 22 were High-School students, 19 were undergraduates, two (2) were post graduates and ten (10) have other forms of education.

**Table 1** Total number of respondents, gender, ages and their education level

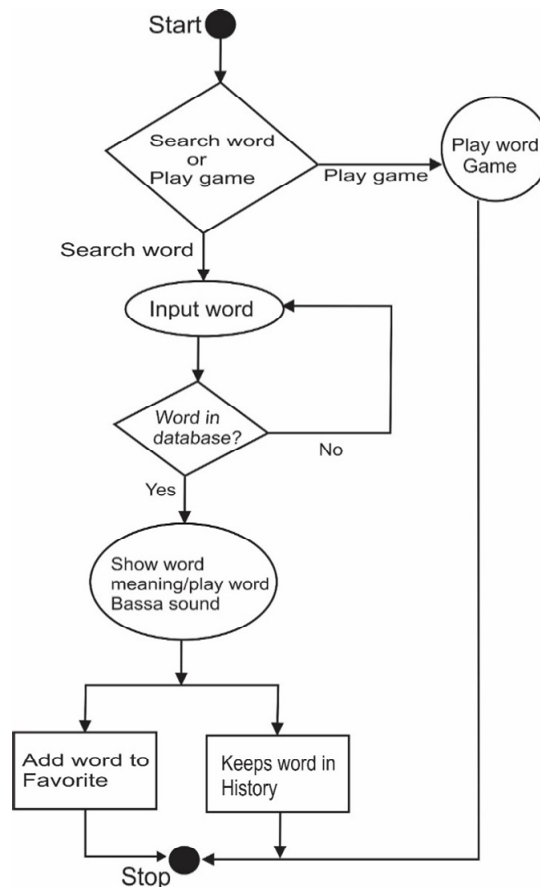
<i>Age Group</i>	<i>Educational level</i>							<i>% Age group</i>
	<i>MA</i>	<i>FA</i>	<i>VS</i>	<i>HS</i>	<i>UG</i>	<i>PG</i>	<i>Other</i>	
17–20	6	7	–	13	–	–	–	11.99%
21–30	5	4	–	9	–	–	–	12.90%
31–40	4	2	–	–	4	–	2	29.42%
41–50	7	3	3	–	5	2	–	41.05%
51–60	6	4	1	–	8	–	1	43.27%
61–65	4	5	–	–	2	–	7	44.08%
Total	32	25	4	22	19	2	10	30.45%

Notes: MA = Male; FA = Female; VS = Vocational School; HS = High School; UG = Under Graduate; PG = Post Graduate; AS = Average Score.

### 3.2 System design

The system was designed using the Unified Modelling Language (UML) tools. The UML is a graphical language that is suitable for visualising software specification, requisite, architecture and design, (Booch et al., 1999). Different activities that should take place in the system for its successful life cycle and their concurrency were designed using the UML activity diagram. This is used to represent the control and data flow. The activity diagram for the Bilingual ED learning system is shown in Figure 1, clearly describing the flow of operations within the system. The activity of the system starts by acquiring choice word input from the user on the startup interface. The user can either select one of the words in the suggested list or type the whole word with the keypad and the system translates the word. The system finally displays the translation and pronunciation of the selected word. The searched word is stored in the history list. The user can also decide to set a word as favourite. The favourite displays the list of the user’s favourite words. The user rather search for the word, can also access the word on the favourite tab. In addition to search for words, the user can also decide to play word game in the system. The word game was designed to encourage the user to gain further interest in the learning of the Bassa Language.

**Figure 1** Activity diagram of the Bassa Bilingual ED



The primary source of data was the aged native speakers of the Bassa language, who were consulted, for better understanding. Data were gathered on home domain terminologies in English language and translated into Bassa taking their context in the English text into consideration. The application software developed for this work can run on mobile devices with Android Operating System (OS). The need to develop a bilingual ED as a game-based digital resource for learning the Bassa language of the Liberians is essential for educational development and prevention of the extinction threat posed on the language. Considering the current dynamic technological and pedagogical developments, mobile games have been suggested to be a more promising platform for making (language) learning more portable and seamless (Hung et al., 2018).

### 3.3 *System structure*

Object Oriented Programming (OOP) approach including sixteen classes were used for the system structure. The classes consist of four categories namely: Adapters, Fragments, Activities and normal classes. There are four fragments.

- 1 *Home Fragment*, which is responsible for displaying the “word for the day”. This is done by showing the days date, word for the day, the Bassa meaning of the word and a speaker button to pronounce the meaning of the word.
- 2 *Game Fragment* is responsible for displaying the entrant page for the game of the system. It shows a widget from which the difficulty level of the game can be chosen and the highest score attained by users playing the game.

The player can choose the difficulty level in three options such as: “Easy”, “Medium” and “Hard”. One (1) to two (2) syllable words, three syllable words, and four (4) syllable words were categorised as easy, medium and hard levels respectively. Table 2 shows samples of Bassa words as well as syllable categories for difficulty levels. The player can choose levels based on their competence of the language and that the player receives little or no rewards for playing the game. To start the game, the player selects “Start Quiz” button after selecting from either Easy, Medium and Hard options. The “start quiz” button takes the player to the game interface where he can play the game. Ten (10) seconds is fixed as the maximum duration to choose the correct answer as the timer counts down to zero, failure of which results in a time out and the correct answer is displayed to the player, then the next question is presented sequentially. The player has the option to end the game or continue to the next question. The highest score ever had by players of the game as well as options of replaying the game, choosing a new difficulty level or exiting the game from the game menu is presented to the player. The player can, continue either to play or proceed to explore the next difficulty level after having satisfactorily mastered the current level.

The game presents an easy learning content and helps the user gain new knowledge from the game.

- 1 *History Fragment* shows the list of words searched by users of the system sorted in a manner from newest to oldest. When a word in the list is selected, the meaning of the word is shown in the word Meaning Activity and the word becomes the newest searched word.
- 2 *Favourite Fragment* shows the list of favourites marked by the user of the system.

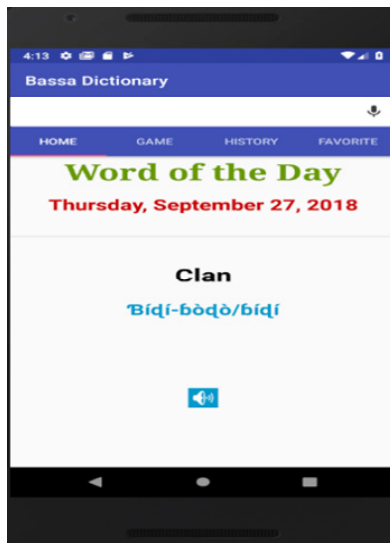
**Table 2** Sample data

<i>Easy</i>		<i>Medium</i>		<i>Hard</i>	
<i>Bassa</i>	<i>English</i>	<i>Bassa</i>	<i>English</i>	<i>Bassa</i>	<i>English</i>
d̩	eat	kǎfíá	Excuse	hwèd̩ɛ̩n̩	good afternoon
Gàa	male	Síqóún	Potato	tááz̩n̩	thousand
Màa	female	ménéé	little	kiáwòd̩	carrot
Taà	home	séd̩éé	Clean	Gèd̩èpòd̩	God
gm̩ě	chair	wúqúá boy	Young	Háq̩èd̩údyá	halleluiah
Nà	walk	Dyú pèd̩è	Baby	Gmàà sùà	ex wife
Ní	water	Sè dúí	inherit	Đííè dyú	first cousin
Pí	cook	Peḍe ma	Sold	Se múàún kpá	unhappy
D̩ḍ	buy	Zà nyíóún	Greet	Wé nòmò dyíin	good day
Zò	Beg	Kpé hwè dyí	Weak	Ní gid̩í	quiet

### 3.4 System implementation

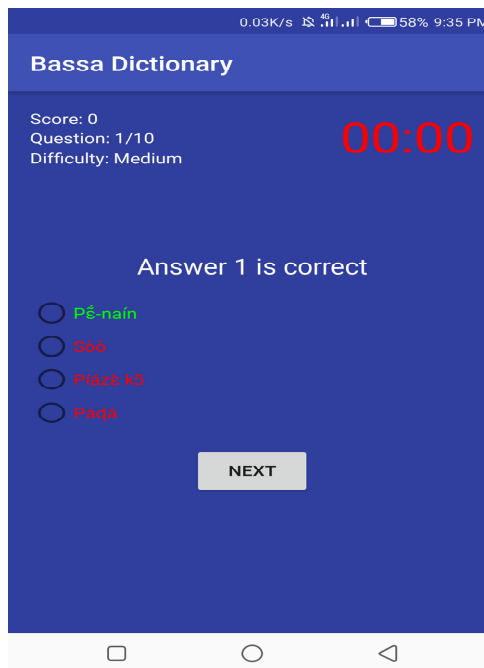
The system was implemented using Android programming language on the Java Platform. Java 10.02: This comprises of the Java Development Kit (JDK) and Java Runtime Environment (JRE) by Oracle Corporation for development of software based on the java programming language. Android Studio SDK provides more intelligent features than most Android programming IDE. It provides features for error highlighting, code colouring and autosuggestion. The system comprises of four main aspects. The home interface (see Figure 2) shows the word of the day label, the date of the day and the English word with the Bassa corresponding translation. There is a speaker button on the home page to pronounce the Bassa translation of the English word (Figure 2).

**Figure 2** Home fragment interface of the system

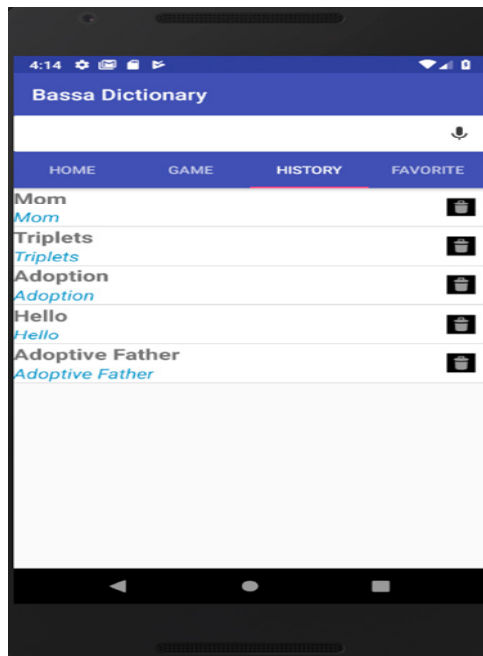


The Game aspect shows the game entry interface (see Figure 3). The player can choose level based on their competence of the language. To start the game, the player selects “Start Quiz” button after selecting from either Easy, Medium and Hard options. The “start quiz” button takes the player to the game interface where he can play the game. The game displays an English word from the six categories with four options in Bassa language. The player is expected to choose an option that presents the correct word, spelling and the diacritics in Bassa language corresponding to the English word. Ten (10) seconds is fixed as the maximum duration to choose the correct answer as the timer counts down to zero, failure of which results in a time out and the correct answer is displayed to the player, then the next question is presented sequentially. The order of presentation of the search history is from the most recently searched word to the oldest.

**Figure 3** Game fragment interface of the system



The player has the option to end the game or continue to the next question. The highest score ever had by players of the game as well as options of replaying the game, choosing a new difficulty level or exiting the game from the game menu is presented. The player can proceed to explore the next difficulty level after having satisfactorily mastered the current level. The History interface shows the list of words searched (see Figure 4).

**Figure 4** History fragment interface of the system

#### 4 Availability of digital data

Several challenges were faced in developing the Bilingual ED learning systems for a low resource language such as Bassa language. The data needed for the system database were not available in digital form because there was no one who has embarked on gathering or digitising such data. The sources such as Internet and Religious book explored in search of the data for this research work offered little or no help at all. The ED system is domain dependent; data availability and adequacy are essential to the development of any ED system. In this research, various domains expected to provide the needed data for the study were explored however, this resulted in little or no success. The domains explored were subsequently discussed in the following section. The sample data are presented (Table 2) with each English word on the same row with the corresponding Bassa meaning.

The availability of internet digital resources would have resolved some of the data challenges unfortunately it was not the case for Bassa language text data since no previous work exists on the subject. This is so because only a few people among the native speakers have good understanding of reading and writing in the language. Hence, it was difficult for even the indigenes to embark on creation of a digital database for the language. After thorough research, it was discovered that the Bassa language has a Holy Bible, however, limited in use. The Holy Bible found only in hard copies consists of religiously bounded terms, which necessitated the need for the Bassa language experts. The Holy Bible is purely Bassa language texts with no corresponding English translation

until you placed an English Bible by its side. Data from the Bible were not adequate for this present research because it does not include terms from other domains aside religion.

#### *4.1 Data collection and grouping*

Data were collected from two primary sources, which include the Bassa indigenes who are mostly the aged native speakers of the language. Most data of English words and their corresponding translation comprising one thousand one hundred home domain terms were collected from this source. The Liberia Translation and Literacy Organisation, an organisation established to translate English literature into languages of Liberia was the second source consulted for data. English language text corpus was gathered on home domain terminologies and translated into Bassa language taking their meaning in context into consideration. Table 2 shows samples of collected text data in Bassa language.

The home domain terminologies gathered were categorised into six groups including Family, Food, Fruit, Greetings, Utensils and Others. Others include living things, and non-living things that are common to the environment and some common words which are used for communication.

#### *4.2 Data analysis*

The sample data gathered were subjected to processing operations such as the pre-processing, which includes size reduction in audio and deletion of noise from recorded Bassa terminologies in order to enhance the application users perceived response time.

Audacity® 2.2.2 version, an open source, cross-platform audio software was used for recording and removing of the noise in the audio recorded. The maximum play length for the audio is 5 second and since the platform on which the application is going to run requires low memory, the audio format was compressed to .mp3.

## **5 Evaluation**

The qualitative evaluation method along with the Mean Opinion Score (MOS) were used to evaluate the developed Bilingual ED learning system. Questionnaires which captured the respondent's age, gender, home town/county and educational level were administered to Bassa natives of age ranging from 10 to 65 years. The respondents were asked to provide the Bassa meaning of some English words. The questionnaires designed comprising of thirty (30) words in different categories (Food, Fruits, Greetings, Family, Utensils and Others) were administered to respondents who are Bassa native speakers in Liberia. The questionnaires have Thirty (30) questions extracted from the six (6) categories (Family, Food, Fruit, Greetings, Utensils and Others). Five (5) questions were taken from each of the six (6) categories totalling to Thirty (30) questions.

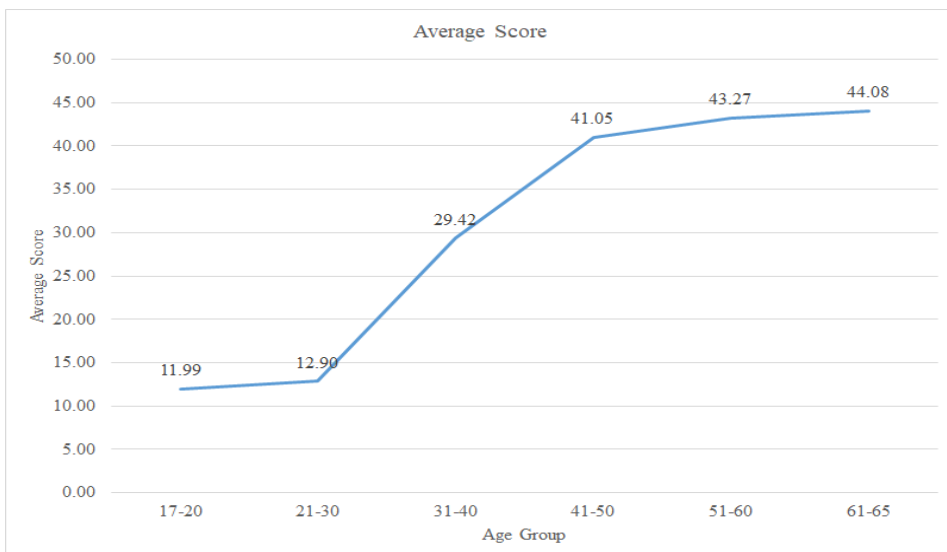
The questionnaires were distributed within Liberia, Translation and Literacy Organisation (27 respondents), 15 secondary school students of the Spiritan Academy School (a secondary school in Liberia) and the University of Liberia (15 respondents). These environments were suitable because it was intended to test the level of understanding of the Bassa language among the natives. The questionnaires were administered to Bassa ethnic group only. The translations were intended to be correctly

spelled and tone marked in Bassa orthography. It was important to start the language learning from identifying the correct spelling and writing aspect because this aspect was observed to pose a major challenge to Bassa learners. It was discovered that even those who seem to have a good level of understanding of the language could not write it correctly. The MOS evaluation was conducted in order to capture how well people translate English words to corresponding Bassa word and the result to be compared with the developed system translation.

## 6 Result discussion

The result of the evaluation (see Figure 5) shows the age group, the average score and the percentage score of each age group. That is, the number of questions whose spelling and the diacritics correctly identified by each age group out of the questions presented to them. The age group of 17–20 got 11.99% correct, age group of 21–30 got 12.90% correct, age group of 31–40 scored 29.42% correct, age group of 41–50 scored 41.05% correct while age group of 51–60 got 43.27% correct and age group of 61–65 got 44.08% correct. The percentages of the correct answers, termed percentage of correctness provided by the respondents based on the age ranges are presented in this study.

**Figure 5** Object percentage scores of the age groups



### 6.1 Level of understanding among the natives

Figure 5 presents the percentage scores for each age group. Age groups from 17–40 scored less than 40%. This result has revealed that the level of understanding of Bassa among the natives is very low especially among the younger Bassa natives. The evaluation results also show that it is majorly the elderly natives who have fairly good knowledge of the Bassa language. This result of less than 50% even among the elderly natives is an indication that the language is gradually eroding away.

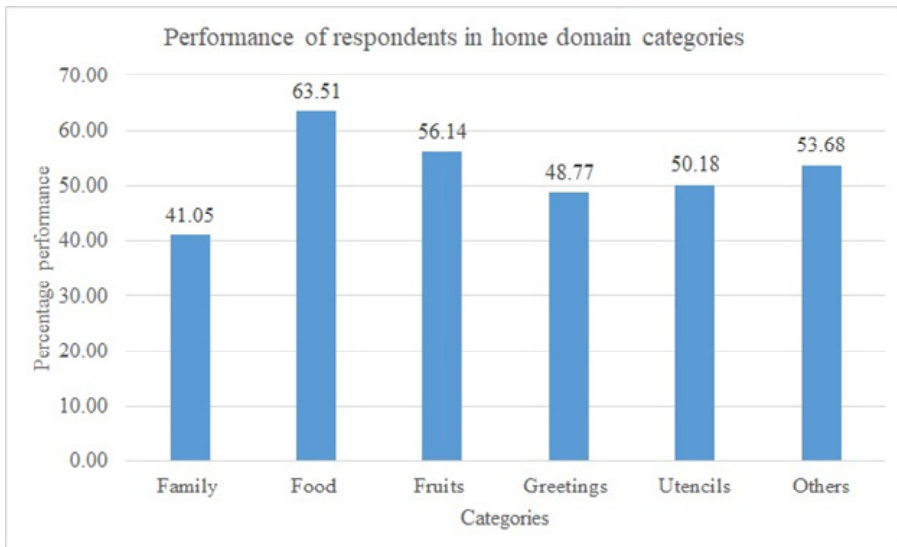


The result of the evaluation carried out revealed that the knowledge of the language is directly proportional to the age (Figure 5). This implies that the elderly has better knowledge and understanding of the language than the younger ones. The younger natives have less understanding in speaking and little or no understanding in writing the language. This may be owing to lack of interest in the language as a result of civilisation. Consequently, the language stands the risk of disappearing with the passing away of the elderly natives who currently have a custody of about average of its knowledge. It eventually dies when there is none to speak it.

6.2 Relationship between level of understanding and various language domains

From the evaluation, it was revealed that respondents scored better in the Food and Fruit categories, follow by Others, Greetings, Utensils and Family categories respectively. Figure 6 shows that people’s familiarity with Bassa words in different domain increases in the following order of categories. Food, Fruit, Others, Utensil, Greetings and Family categories. Bassa people are more familiar with words in the Food and Fruit categories while they are less familiar with words in the greetings and family categories. That Bassa people are more familiar with terminologies in the Food and Fruit is likely to be owing to the fact that food generally is an essential part of human existence and usually peculiar to different culture and language. It can then be inferred that people are more familiar with the language of their local food than other language domains. People are used to their food culture from the cradle and this can hardly be eradicated by civilisation. This can suggest that there is a possibility that the language of any origin can be revived or preserved from extinction through the study and documentation of its food culture.

Figure 6 Percentage performance for domain categories



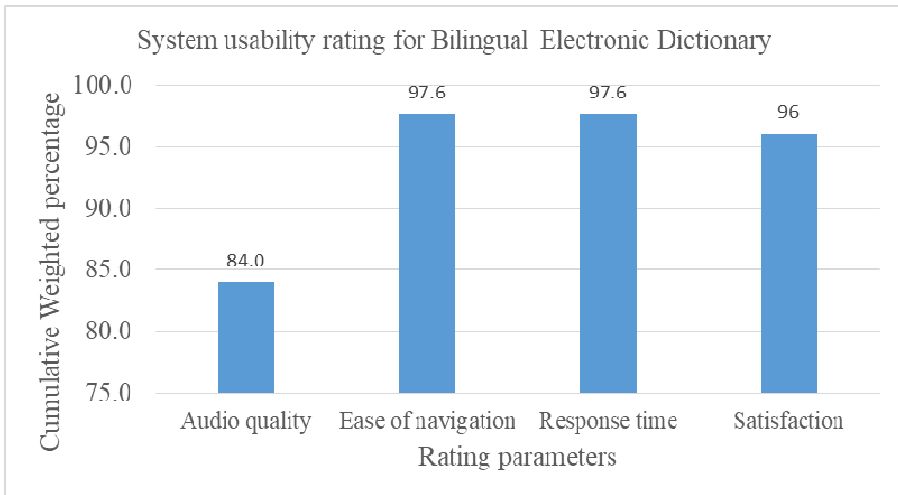
6.3 Game-based learning system to support teaching and learning this language

The developed learning system was tested among the natives to explore its usability, response time and satisfaction (see Figure 7). Respondents were given the system to practice the game after explaining how to use it to them. The users were already familiar with the use of android phones (see Figures 8(a), 8(b) and 8(c)) which show users playing and evaluating the Bassa language learning game and the dictionary after which they were given questionnaire to score the quality of the developed system, as they perceived it. The scoring included a single number in the range of 1 to 5, where 1 is the lowest of the perceived quality and 5 is the highest perceived quality (see Table 3). Twenty-five respondents who have a fair understanding (Read and Write) of the Bassa language were selected to interact with the developed system and they were required to give a rating based on the scheme shown in Table 3. The result obtained revealed that 84.0% rating was given to audio quality, 97.6% for ease of navigation, 97.6% response time and 96% for user satisfaction.

**Table 3** Quality evaluation rating scheme

<i>Weight</i>	<i>Quality</i>	<i>Impairment</i>
5	Excellent	No noticeable
4	Good	Only very slight
3	Fair	Noticeable but acceptable
2	Poor	Strong impairment
1	Bad	Highly degraded

**Figure 7** System usability rating



**Figure 8** User (a) playing the word game (b) using the dictionary (c) the word search

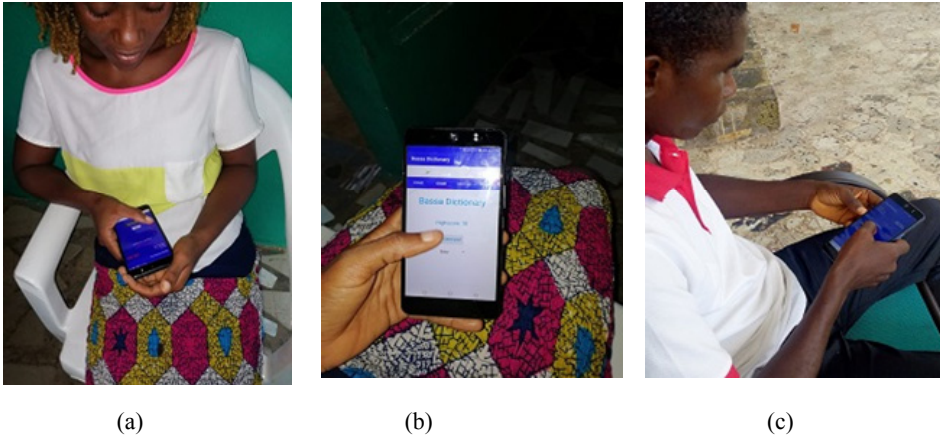


Table 4 shows each respondent’s opinion and attitude of respondents relating to the extent of their level of usage of the developed system. The audio part of the game was scored lowest (84%). This may be owing to the voice recording or the speaker of the device on which the system was installed. Ease of navigation, response time and user satisfaction scored above 90%.

**Table 4** System quality rating for the Bilingual ED

<i>Parameters</i>	<i>Excellent</i> 5	<i>Good</i> 4	<i>Fair</i> 3	<i>Poor</i> 2	<i>Bad</i> 1	<i>Total</i> <i>respondents</i>	<i>Sum of</i> <i>points</i>	<i>Average</i>	<i>Cumulative</i> <i>Weighted</i> <i>percentage</i>
Audio quality	8.00	14.00	3.00			25.00	105	4.2	84.0
Ease of navigation	22.00	3.00				25.00	122	4.88	97.6
Response time	22.00	3.00				25.00	122	4.88	97.6
Satisfaction	20.00	5.00				25.00	120	4.8	96
Average	18.00	6.25	0.75			25.00	117.25	4.69	93.8

#### 6.4 How can the language be preserved?

This work addressed this issue partly by developing a mobile learning instrument with motivating facilities such as games, which ensure the young learners are engaged and their interest motivated. This is consistent with Tan and Atienza (2014) whose work is used as source of reference for learners. The positive effects of games on motivation of students’ learning especially languages have also been affirmed by Zou et al. (2019); Ninan et al. (2019); Chen et al. (2019) and among others.

## **7 Conclusions**

A language is near to extinction when it is only spoken by elderly people. When a few, mostly quite old, speakers remain, the language is endangered and, when there are no remaining speakers, the language is extinct (Thompson and Gleason, 2001). In light of this, the findings of this work reveal that the Bassa language is endangered. It is important that all communities strive to preserve their language(s) as it is a symbol of their culture and identity. This is best done by encouraging the learners' (most especially the youth) interest in the language.

The study developed an English to Bassa Bilingual ED learning system and it has identified the possibility of translating English text to Bassa equivalence text with the corresponding audio pronunciation. The purpose and motivation for the developed system are to make the digitised Bassa text available to the Bassa people and prevent the extinction threat posed on the language. The development of the Bilingual ED will help in promoting the level of knowledge and skills in the Bassa language and the need to document her cultural heritage. The fact that there was no digital document or resource of any kind in existence for Bassa language was a serious challenge for this work. It is believed that this work bridged the gap by providing a digital resource which can assist further research. It was discovered in the course of this work that people are generally more attached to the language of their food culture than other domains.

A language learning resource for Bassa language natives who are currently almost totally losing their heritage was an essential endeavour. The evaluation result showed that the respondents found the device interesting and easy to use. The youth who are mostly students are motivated to learn the language by playing the game. Youth interest in the game-based device will enhance their acquisition of knowledge for better understanding in the language. This has been established in literature (Liu and Chen, 2013). More so, the mobile device provides an unlimited availability for the language since it is accessible anywhere hence encourages easy communication among tourists, marketers and the Bassa locals.

This system can also be used as a language tool for formal and informal education, and enlightenment of the Liberian public on cultural value, resulting in a more civic, conscious and knowledgeable society. This also provides a possibility to salvaging all the endangered languages.

## **8 Limitations of this study**

This research is limited to a bilingual electronic language learning device comprising of only English and Bassa languages. The system could be developed to accommodate other local endangered languages. The texts (corpus) was collected from the home domain. Other domains such as health, education, and business can also be considered. The system includes audio pronunciation of Bassa words along with game. The result of this study could be extended to a talking dictionary for playing back the pronunciations for the words through sound rather than providing it as a simple text. Moreover, it can also be made to accept inputs as sound rather than a text and display back their definition and pronunciation through sound. This feature will make the application useful also to those who cannot read and write texts like illiterates and the disabled.

## References

- Abiola, O., Adetunmbi, A., Fasiku, A. and Olatunji, K. (2014) 'A web-based English to Yoruba noun-phrases machine translation system', *International Journal of English and Literature*, Vol. 5, No. 3, pp.71–78.
- Akinwale, O.I., Adetunmbi, A., Obe, O. and Adesuyi, A. (2015) 'Web-based English to Yorùbá machine translation', *International Journal of Language and Linguistics*, Vol. 3, No. 3, pp.154–159.
- Amfani, A. (2009) *Indigenous Languages and Development in Nigeria*, The Institute of Nigerian Languages, University of Nigeria (Aba Campus): Available online at: <http://inlan.edu.ng/ampani.html> (accessed on 12 April 2018).
- Booch, G., Rumbaugh, J., Jacobson, I. and Ivar, J. (1999) *The Unified Modeling Language User Guide*, 2nd ed., Addison-Wesley.
- Chang, C. and Hwang, G.J. (2019) 'Trends in digital game-based learning in the mobile era: a systematic review of journal publications from 2007 to 2016', *International Journal of Mobile Learning and Organisation*, Vol. 13, No. 1, pp.68–90.
- Chen, M.P., Wang, L.C., Zou, D., Lin, S.Y., Xie, H. and Tsai, C.C. (2020) 'Effects of captions and English proficiency on learning effectiveness, motivation and attitude in augmented-reality-enhanced theme-based contextualized EFL learning', *Computer Assisted Language Learning*, pp.1–31.
- Chen, M-P., Wang, L-C., Zou, Di, Lin, S-Y., Xie, H. and Tsai, C-C. (2020) 'Effects of captions and English proficiency on learning effectiveness, motivation and attitude in augmented-reality-enhanced theme-based contextualized EFL learning', *Computer Assisted Language Learning*. Doi: 10.1080/09588221.2019.1704787.
- CIA-Factbook (2008) *CIA (Central Intelligence Agency) Factbook*, Liberia, The World Factbook, Africa. Available online at: <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/li.html> (accessed on 14 May 2018).
- De Valoes, L. (2014) *Importance of Language: Why Learning a Second Language is Important*, Adjunct Faculty.
- Deksne, D., Skadina, I. and Vasiljevs, A. (2013) 'The modern electronic dictionary that always provides an answer', *Proceedings of the eLex 2013 Conference Electronic Lexicography in the 21st Century: Thinking Outside the Paper*, 17–19 October, Tallinn, Estonia, pp.421–434.
- Eisenlohr, P. (2004) 'Language revitalization and new technologies: cultures of electronic mediation and the refiguring of communities', *Annual Review of Anthropology*, Vol. 33, pp.21–45.
- Eludiora, S.I. (2014) *Development of a English to Yorùbá Machine Translation System*, An Unpublished PhD, Thesis submitted to, Obafemi Awolowo University, Ile-Ife, Nigeria.
- Gamlo, N. (2019) 'The impact of mobile game-based language learning apps on EFL learners', motivation', *English Language Teaching*, Vol. 12, No. 4, pp.49–56.
- Grenoble, L.A. and Whaley, L.J. (2006) *Saving Languages: An Introduction to Language Revitalization*, Cambridge University Press.
- Hung, H.T., Yang, J.C., Hwang, G.J., Chu, H.C. and Wang, C.C. (2018) 'A scoping review of research on digital game-based language learning', *Computers and Education*, Vol. 126, No. 8, pp.9-104.
- Lerlerdthaiyanupap, T. (2008) *Speech-Based Dictionary Application*, Master's thesis.
- Levy, P. and Spilling, M. (2008) *Liberia*, Vol. 16, Marshall Cavendish.
- Li, Y., Cao, L., Yu, H., Cheng, C. and Li, S. (2010) 'The development of dictionary tools on window mobile platform', *Proceedings of the 2nd International Conference on Computer Engineering and Technology (IC CET)*, IEEE, Vol. 2, pp.V2-728–V2-732.
- Liu, E.Z.F. and Chen, P.K. (2013) 'The effect of game-based learning on students' learning performance in science learning – a case of “conveyance go”', *Procedia-Social and Behavioral Sciences*, Vol. 103, No. 26, pp.1044–1051.

- Ninan, O.D., Iyanda, A.R. and Akinde, A.E. (2019) 'A mobile game-based learning system for diacritic insertion', *International Journal of Smart Technology and Learning*, Vol. 1, No. 4, pp.344–360.
- Ninan, O.D., Iyanda, A.R. and Williams, O.A. (2017) 'Development of a mobile tourist assistance for a local language', *American Journal of Tourism Management*, Vol. 6, No. 1, pp.5–9.
- Olorunlome, A.B. (2016) *Development of a Multimedia Multilingual Dictionary for Nigerian Indigenous Languages*, An Unpublished M.Sc. Thesis submitted to, Obafemi Awolowo University, Ile-Ife, Nigeria.
- Olson, D.R. (1996) *The World on Paper: The Conceptual and Cognitive Implications of Writing and Reading*, Cambridge University Press.
- Olukoju, A. (2006) *Culture and Customs of Liberia*, Vol. 1530, Publishing Group, Greenwood.
- Osunade, O., Dawodu, D. and Phillips, O.F. (2015) 'A simple data driven Yoruba language dictionary', *Journal of Literature, Languages and Linguistics*, Vol. 10, pp.2422–8435.
- Parodi, E., Bedek, M.A., Seitlinger, P., Vannucci, M., Jennett, C., Ruskov, M. and Celdran, J.M. (2014) 'Analysing players' performance in serious games', *International Journal of Technology Enhanced Learning*, Vol. 6, No. 3, pp.237–248.
- Shaffer, S. (2011) *Language Group Specific Informational Report*, Rhode Island College, M.Ed. TESL Program, Bassa.
- Sung, H.Y. and Hwang, G.J. (2013) 'A collaborative game-based learning approach to improving students' learning performance in science courses', *Computers and Education*, Vol. 63, pp.43–51.
- Tan, M.S.S. and Atienza, R.O. (2014) 'Librorum: a crowdsourcing Filipino English dictionary mobile application', *In TENCON 2014-2014 IEEE Region 10 Conference*, IEEE, pp.1–6.
- Thompson, R.B. and Gleason, J.B. (2001) *Language Death*, David Crystal, Cambridge University Press, Cambridge; *Applied Psycholinguistics*, Vol. 22, No. 2, pp.269–273.
- Tsai, C-Y., Hsu, J-M., Tsai, H-H., Yu, P-T. and Huang, W-F. (2016) 'A multi-party Mahjong-like spelling game for English vocabulary learning', *International Journal Innovation and Learning*, Vol. 19, No. 4, pp.397–411.
- Zaibon, S.B., Azman, F.N. and Shiratuddin, N. (2018) 'Enhancing performance of student in web programming using digital educational comics', *Journal of Telecommunication, Electronic and Computer Engineering (JTEC'18)*, Vol. 10, Nos. 2/4, pp.161–165.
- Zelalem, A. (2010) *Design and Implementation of Multilanguage Electronic Dictionary for Smart Phones: A Dictionary of Amharic, Afaan Oromo, English And Tigrigna Languages*, Published M.Sc. Thesis submitted to, Addis Ababa University School of Graduate Studies.
- Zou, D., Huang, Y. and Xie, H. (2019) 'Digital game-based vocabulary learning: where are we and where are we going?', *Computer Assisted Language Learning*, pp.1–27.