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| RESEARCH ARTICLE

Text-To-Speech Software for Promoting EFL Freshman Students' Decoding Skills and Pronunciation Accuracy

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| ABSTRACT

Two groups of freshman students, enrolled in a Vocabulary I and Reading I courses, participated in the study. Before instruction, both groups took a recognition (vocabulary) and a production (oral reading) pre-test. Comparisons of the pre-test scores showed no significant differences between the experimental and control group in decoding skills and pronunciation proficiency. Then, both groups were exposed to the same in-class vocabulary and reading instruction. They covered the same lessons, skills, exercises, and tests. Since freshman students have problems in producing phonemes, consonant clusters, word stress and lack skill in associating written graphemes with their corresponding phonemes, read word by word and lack oral reading fluency, the experimental group used a text-to-speech (TTS) software called NaturalReader. Every week the students typed or copied and paste the lessons they took in class from the textbook into NaturalReader and practiced listening to the lessons read by the software. They could listen to the text as many times as they needed in the language lab or at home and could adjust the software reading speed. Every 4 weeks, experimental students took an oral reading and a vocabulary test and at the end of the semester (after 12 weeks), both groups took a recognition (vocabulary) and a production (oral reading) posttest. Results showed significant differences between the experimental and control groups as a result of using the NaruralReader. Improvement was noted in the decoding skill enhancement, reading fluency and pronunciation accuracy but not in vocabulary knowledge. Results showed slow but gradual improvement. Significant improvement was noted after 8 and 12 weeks. There was a positive correlation between the number of lessons and texts practiced and weekly practice time and decoding and pronunciation proficiency posttest scores. The students reported positive attitudes towards practicing decoding and pronunciation via NaturalReader. Procedures, results and recommendations are given in detail.

| KEYWORDS

Text-to-speech software, NaturalReader, decoding skills, word identification skills, word recognition skills, production skills, grapheme-phoneme correspondence, sound-symbol associations, pronunciation accuracy, oral reading.

| ARTICLE INFORMATION

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1. Introduction

Text-to-speech (TTS)[1] is a type of assistive technology that reads a digital text aloud. It is also called "read aloud" technology. TTS converts printed words on a computer or any other digital device into audio which the students can listen to and repeat what they have heard. Many research studies in the literature indicated that TTS are helpful for students of all ages, for those who are normal, and those with special needs, fand or native speakers as well as foreign/second language learners. TTS have been used for developing a variety of language skills such as listening, reading comprehension, orthography, vocabulary, and writing.

[1] https://www.techradar.com/best/best-text-to-speech-software

Due to the importance of TTS, numerous studies in the literature compared TTS software with human voice. For example, students who learned from a modern TTD engine were not statistically different in their learning outcomes, perceptions, or cognitive efficiency measures from those who learned from a recorded human voice. This means that TTS software technologies may have reached a point where they can credibly and effectively deliver the narration for multimedia learning environments (Craig & Schroeder, 2019). A significant difference between TTS and teacher-led dictation on students' vocabulary performance was found. There was a correlation between TTS dictation and teacher-led dictation scores, i.e., students who performed better with teacher-led dictation also obtained higher scores with TTS dictation (Chiang, 2019). In addition, students with learning disabilities who struggle with reading and comprehension benefit from TTS software when used as a supplement to explicit teacher instruction. However, the TTS software was not as effective as a human reader on listening comprehension for students with learning disabilities (Brunow & Cullen, 2021). For speech quality (naturalness, intelligibility, comprehensibility, and accuracy), the human samples earned higher ratings than the TTS samples. For focus on a linguistic form such as past -ed perception, the TTS and the human-produced samples were equivalent (Cardoso, Smith & Fuentes (2015). In Brazil, EFL learners showed overall positive attitudes towards the pedagogical use of modern English TTS software, and they declared that they would like to use the TTS system as a learning tool for improved speech quality, learners' cognitive processing of TTS-generated texts and the opportunity to focus on form (Bione, Grimshaw & Cardoso, 2016).

A second group of studies focused on the use of TTS software as a tool for developing audio/listening materials for listening comprehension. Experiments with TTS-generated audio files have been used in the classroom as an alternative for traditionally used audio equipment such as compact discs and listening tests. Those experiments showed positive results (Sha, 2010). Moreover, Oktalia and Drajati (2018) reported that EFL teachers gave positive responses to the integration of TTS as a tool for creating listening materials by using the TPACK (Technological, Pedagogical, Content, Knowledge) model and by utilizing Google Site as the media for delivering the listening material. EFL teachers found TTS useful for the language learning process. At the University of Mauritius, Rughooputh and Santally (2009) stated that the integration of TTS software in the lecture slides, with the help of teaching aids such videos, animations, and music had pedagogical, administrative and financial benefits.

A third group of studies explored the effects of using TTS software on elementary, secondary and college students with reading problems and/or moderate intellectual disability such as developing reading fluency and comprehension by adults with reading difficulties, struggling high school students with learning disabilities, and nonnative-English-speaking college students who were experiencing reading difficulties in their freshman year at a community college in the United States (Coleman, Killdare, Bell & Carter, 2014; Young, Courtad, Douglas & Chung, 2019; Foshage, 2019; Baker, 2015); supporting the reading comprehension of at-risk pre-adolescent readers through the use of TTS technology combined with strategic instruction (Anderson, 2009); using a self-paced word-to-text-integration reading tasks by 7th grade ESL students in Fall (T1) and Spring (T2), consisting of three text manipulation types (anaphora resolution, argument overlap, anomaly detection), in simple and complex passages (Mulder, van de Ven, Segers, Krepel, de Bree, de Jong & Verhoeven, 2021); for developing EFL college students' fluency and comprehension using repeated-reading and listening-while-reading via TTS apps (Amin, 2022); and language, reading, and executive function measures as predictors of comprehension by 8 to 12 year-old children with reading difficulties using TTS (Keelor, Creaghead, Silbert, Breit-Smith & Horowitz-Kraus, 2018); and is used by blind students to read and listen to texts, emails and social media posts (Al-Jarf, 2021a).

A study with third and fourth-grade students with reading disabilities demonstrated a significant effect of three book formats (eBooks with full TTS narration, eBooks with selected vocabulary and TTS support, and traditional print books with no added supports) on comprehension as measured by oral retelling, but not for comprehension when measured by multiple-choice questions (Gonzalez, 2014). Another study with three third-grade students with moderate intellectual disability revealed the ability to correctly answer questions about an e-text read aloud via TTS software by either giving the answer from memory or by searching the e-text and replaying the target text to find the correct answer on their own. A functional relationship was also detected for both generating questions using an iPad and answering comprehension questions (Wood, Browder & Spooner, 2020).

For fifth-grade students who use a language at home that is different from the language of instruction at school, TTS software can be useful as it provides auditory input next to an on-screen text. All content was read aloud via the TTS software. Students with a low self-assessed proficiency in their home language and those who often watch television and read books in the language of instruction at school use TTS as an important support tool more in the language of instruction (Van Laere & Braak, 2017).

Moreover, Dutch disabled readers read eight stories containing embedded homophonic pseudoword targets (e.g., blot/blod), with or without support of TTS software. Assessment results revealed orthographic learning during independent silent reading. Target spellings were correctly identified more often, named more quickly, and spelled more accurately than their homophone foils. This means that all readers, even poor readers of transparent orthographies such as Dutch, were capable of developing word-specific

knowledge. However, passive listening to the auditory presentation of the text by the TTS software had a negative effect on orthographic learning (Staels & Van den Broeck (2015).

At the elementary and middle school level, students with written expression disorders, described in writing what was happening in a picture-based writing prompt. They also responded in writing using a word processor software alone and using a word processor in conjunction with the word prediction, the TTS software WordQ. The use of the word prediction and TTS features in WordQ proved to be effective. The students' written work had significantly fewer spelling errors, increased syntactic maturity when using the WordQ software (Cunningham, 2013).

At Azad University of Ghorveh in Iran, intermediate accounting students who participated in an English Reading Program learnt word stress, word intonation, pitch contour, and fluency of English reading through TTS. The TTS software had a positive effect on improving reading features in the EFL context of the intermediate students as a result of using TTS software (Meihami & Husseini, 2014).

In Turkey, Eksi and Yesilçinar (2016) reported that the TTS software proved to be effective self-study tools in improving university EFL teacher trainees' pronunciation. EFL teacher trainees perceived a native-like accent as a measure of being a good language teacher.

Although a plethora of studies in the literature investigate the effect of TTS software on leaning, the literature review shows lack of studies in Saudi Arabia in which EFL college instructors integrate TTS software to help students with EFL learning difficulties develop their reading and listening comprehension skills, reading features (word stress, word intonation, pitch contour, and fluency), pronunciation, vocabulary, orthography, and spelling.

Furthermore, freshman students majoring in translation at the College of Languages and Translation (COLT) lack skill in associating written graphemes with their corresponding phonemes, have problems in producing phonemes, consonant clusters, word stress, read word by word, and lack oral reading fluency. Results of a listening-spelling test given to a sample of Saudi freshman students majoring in translation at COLT indicated that the students had more problems with whole words than graphemes and phonemes. 63% of the spelling errors were phonemic/phonological, i.e., errors in which the misspelled word does not sound like the target word because the whole word, a consonant, a vowel, a syllable, a prefix, a suffix, a grapheme or a grapheme cluster was not heard at all, was misheard, was added, or reversed with another, and 37% were graphemic/orthographic, i.e., errors in which the written form or grapheme used for the misspelled part does not correspond with the target word or target grapheme. The students confused vowel graphemes that have the same sound, confused consonant graphemes that have the same sound, confused vowel and consonant digraphs, deleted silent vowels and consonants, deleted a vowel in vowel digraphs, added or deleted final silent vowels, doubled consonants or vowels, reduced double consonants or double vowels, represented consonants with hidden sounds phonetically, reversed CV and VV sequences, and confused homophones. Some of the phonemic problems that the students had were inability to hear and discriminate all or most of the phonemes in a word, inability to discriminate vowel phonemes and hear the final syllable or suffix. They had graphemic problems with vowel digraphs, silent vowels and consonants, double consonants, and homophones (Al-Jarf, 2019a; Al-Jarf, 2010; Al-Jarf, 2009a; Al-Jarf, 2008; Al-Jarf, 2007a; Al-Jarf, 2005a; Al-Jarf, 2005b; Al-Jarf, 1999).

Moreover, EFL Arab students and students majoring in translation and interpreting at COLT have numerous pronunciation weaknesses such as (i) mispronouncing English vowels in *Google, Moodle, Uber, Nixon, London;* (ii) replacing consonants absent in L1 (p, v) by their equivalents (*bebsi, jafa*); (ii) pronouncing words the way they are spelled *(Nazi, Nike, Huawei, Hyundai, Wednesday);* (iii) geminating consonants in city and country names (*Peking; Venezuela, Minnesota*); (iv); inserting a vowel in consonant clusters in Proper Nouns and acronyms (*Zelinsky, Logansk, SNAS, GMC*,); (v) breaking words into two sub-words *(Kasper+ sky, Sky+ pe*); and (vii) transferring Arabic stress rules to English words (McDonald, Mayflower) (Al-Jarf, 2022e; Al-Jarf, 2022f).

Since most of the prior studies reported above showed positive effects of using the TTS software on students' language learning, this study proposes the integration of TTS software in vocabulary and reading courses offered to freshman students at COLT to help the students decode the printed words, i.e., connect the printed form of the words with their spoken form (pronunciation). This study also aims to explore the impact of the TTS software on EFL freshman students' word decoding skills and pronunciation accuracy and explore students' attitudes towards using the TTS software as an extension activity, in addition to class instruction.

2. Theoretical Framework

According to Al-Jarf (2019b), Al-Jarf (2015b), Al-Jarf (2010), Al-Jarf (2009b) and Al-Jarf (2007), helping Saudi EFL freshman students decode and pronounce words correctly is significant for improving their reading and pronunciation competence. In decoding, word identification or word recognition, readers convert the written graphemes into spoken phonemes, i.e., decoding involves

making the correct grapheme-phoneme associations. Decoding is a basic skill that the students need to acquire in a foreign language as it is a prerequisite of reading comprehension. Decoding consists of the following subskills:

1) *Sight word recognition* which refers to the ability to recognized words as a whole at a glance.
2) *Phonic analysis*, i.e., the identification of written words by their sounds. It involves the association of speech sounds and the blending of these sounds into syllables and words. It includes identification of speech sounds, letter combinations (blends, digraphs, and diphthongs), syllables, morphemes and accents, spelling patterns, similar beginnings and endings of words, letter sounds related to their initial, medial and final positions within words, and positions of the mouth, lips, teeth, and tongue t sound out letter combinations.
3) *Structural Analysis* which involves identifying words by breaking them into their appropriate units. it includes identifying derivatives, roots, prefixes, suffixes, and hyphenated words), see relationships among word from, common origin words, identifying identical endings denoting plurals, comparatives, identifying compound words, contractions, possessives and syllabication.

Therefore, to make the correct grapheme-phoneme associations, Al-Jarf, (2022a); Al-Jarf (2006) recommended that students need to:

1) Connect the printed form of a word, compound, acronyms, abbreviations, symbols or formula with its pronunciation. The students need to learn the following: 2005a;
   - Hidden sounds as in the following examples:
     - Ch pronounced as /k/: *chemical, mechanical, machine, mechanism.*
     - Different pronunciations of -tion*: combustion, digestion, consumption, negotiation*.
     - Different pronunciations of -sion: *tension, vision, corrosion, compression, pressure.*
     - Pronunciation of sc, cc: *scientist, accelerate, access, account*
     - /ʃ/ sound: *insurance, quotient, coefficient, social, facial.*
     - /ʃ/ sound: *potential, artificial, partial, Inertia.*
     - /tʃ/ sound: *structure, saturation, temperature, opportunity, mutual.*
   - Double consonants: *account, recommend, announce, assignment, assess, access, attack. Allow, affect.*
   - Silent letters (vowels and consonants): *psychology, design, tough, resign, thought, although, apple, imagine, guess, guide.*
   - Consonant graphemes with same pronunciation as in:
     - *Check, technique, quick, school, chemistry.*
     - *Follow, enough, philosophy.*
     - *Assign, central, society, muscle*
     - *Show, machine, sure, session, partial, pressure, attention, electrician, social, facial.*
     - *Change, mutual, picture.*
     - *Get, general, change, soldier, jet, decision, usual, casual.*
   - Words with the same vowel digraphs but different pronunciation:
     - *heart, heard, clean, clear.*
     - *Court, country, count, couple, group.*
     - *Grow, clown, grown.*
     - *Food, flood.*
   - Words with different vowel digraphs but the same pronunciation: *receive, lead, speed, relieve, impede, machine, unique.*
   - Homophones: *site, cite, sight.*
   - Homographs: *read & read; bass & bass.*
   - Words with 2 stress forms according to their part of speech: 'present (N, pre'sent (V).*separ'ate* (V), '*Separate* (Adj; 'complement (N), comple'ment (V),
   - Compounds: *net/work, international, Arab-American,*
   - Pronunciation of foreign words: *attaché, machine, entrepreneur, rapport, massage, buffet, gourmet, Nazi, radii.*
2) Connect words with spelling/pronunciation changes that take place when suffixes are added:
   - *Describe, description*
   - *Coordinate, coordination*
   - *Adapt, adaptable, adaptability*

- *Part, partial*
- *Analyze, analyst; chemistry, chemist*

3) Connect words with their spelling variants: *Technique & techniq; dialogue & dialog; Programme & program.*

4) *Suffixes that change and do not change pronunciation:*
   - *Industrial, industrialize, industrialization*
   - *Photograph, photography, photographic.*
   - *Electric, electrical, electrician.*

3. Methodology

3.1 Subjects

Two intact groups of freshman students participated in the study. The experimental groups consisted of 43 students and the control group consisted of 45 students. Students is both groups were majoring in translation at the College of Languages and Translation (COLT), King Saud University, Riyadh, Saudi Arabia. Both groups were enrolled in their first Vocabulary Building (3 hours) and Reading I (4 hours) courses, that the author taught. They were taking other English language courses such as Listening 1 (3 hours per week), Speaking 1 (3 hours), Writing 1 (4 hours), andGrammar 1 (2 hours). The students were all Saudi and they all speak Arabic as their native language. Their ages ranged between 18-20, with a median of 18 years. The experimental group used a TTS software as a supplement to in-class instruction that depended on the textbook. The control group used the textbook only with oral reading of texts and vocabulary lessons by the instructor in class.

At the beginning of the semester, and before instruction started, the experimental and control groups were pretested. They were given a recognition (vocabulary) test and a production (oral reading) test. The recognition test aimed to assess the students' word decoding skills, whereas the production test aimed to assess the students' pronunciation proficiency. Analysis of the pretest scores showed no significant differences between the experimental and control groups in word decoding and pronunciation accuracy (Recognition T = 2.49; df = 86; p>.073; production T = 1.89; df = 86; p<.069 respectively).

Table 1: Mean, Media, Standard Deviation, Standard Error and Range of the Recognition (Vocabulary) and Production (Oral reading) Pre-test Scores

Groups	Tests	N	Mean	Median	Standard Deviation	Standard Error	Range
Experimental Group	Recognition (Vocabulary)	43	33.92%	24 %	3.32	.46	16% - 38%
	Production (Oral reading)	43	35.19%	35.9%	4.8	.26	15% - 55%
Control Group	Recognition (Vocabulary)	45	34.76%	18%	3.29	.66	05% - 54%
	Production (Oral reading)	45	32.3%	34.7%	4.40	.21	14% - 53%

3.2 In-class Instruction

Both groups were exposed to the same in-class instruction that depended on the textbook. They studied the same textbook titled "*Vocabulary in Use: Pre-intermediate and Intermediate*" (4th Edition), by Stuart Redman (2017). The textbook consists of 100 lessons. Only 50 lessons were covered in class. Both groups covered the following lessons: *Classroom language, prefixes, noun suffixes, adjective suffixes, compound nouns, compound adjectives, nouns and verbs with the same form, idioms, collocations, and fixed expressions, verbs, and adjectives followed by prepositions, preposition + noun, some functions, phrasal verbs (form, meaning, grammar and style), have and have got, make, do and take, give, keep, break, see, go (uses and expressions), leave, catch, and let, get (uses and expressions), uncountable nouns and plural noun, partitives, the senses, the physical world, countries, nationalities and languages, animals and insects, the body and what it can do, around the home, the place where you live, physical injuries, money, clothes, cooking and restaurants, food, inthe office, jobs, computers and the internet, and global problems.*

The following word decoding and pronunciation skills were emphasized in the course: Pronunciation (recognizing silent letter, hidden consonants, double letters, words with the same vowel but different pronunciation and words with different vowels but same pronunciation, syllabication, and stress); spelling changes and spelling variants; word formation: prefixes, suffixes, derivatives, and compounds; part of speech, count/non-count, singular & plural forms; idioms and collocations; word families; American vs British usage; word synonyms and antonyms; English and Arabic meanings.

Students in both groups did most of the vocabulary exercises in class. While doing the exercises, the instructor monitored their

work and provided individual help and feedback. Only errors related to the topic or rule under study were highlighted. Feedback was provided on the presence and location of errors, but no correct forms were provided. The students had to check the rules and examples in the book by themselves. Extra credit was given to students who could do all the items in an exercise correctly and within the designatedtime (Al-Jarf, 2021).

As for assessment, students in both groups were given two in-term tests and several pop-quizzes.The following skills were covered by the quizzes: Recognizing silent letters, recognizing hidden consonants, recognizing double letters, recognizing words with the same vowel but different pronunciation and words with different vowels but same pronunciation, adding prefixes, suffixes, recognizing derivatives and compounds, identifying the part of speech, count/non-count, recognizing singular & plural forms, American vs British usage, word synonyms and antonyms, idioms and collocations, capitalization, giving the English definition, giving the Arabic meaning, and using words, idioms and phrasal verbs in sentences. All the tests were graded and returned to the students with commentson strengths and weaknesses. Words of encouragement were given. Answers were alwaysdiscussed in class.

3.3 Treatment (Practice with TTS software)

Students in the experimental group used TTS software called NaturalReader (https://www.naturalreaders.com), because registration is free. It is flexible and easy to use. The student can choose to hear the text in a male or female voice, in an American or British accent, on the desktop/laptop, online or using its mobile App. It can be installed on the desktop or laptop and launches from there. It can be installed as a Google Chrome Extension in which case the students can to listen to webpages, online ebooks, Google Docs, and emails. It can be installed as a mobile App so that the student can continue listening on the go with Android or iOS smart mobile phone.

The students used the NaturalReader software on their own, out of class. They were introduced to NaturalReader, were given the URL and were asked to download it on their laptop, as a Chrome Extension or as an App on their mobile. The instructor showed the students the different tools and options of NaturalReader, how to copy and paste a text into the software and how to listen and repeat what they have heard and how to adjust the reading speed.

Every week the students typed and/or copied and pasted the vocabulary lessons and reading passages they took in class from the textbook into the software. They practiced listening to the lessons read by the software while following the parts being read on the screen. They could listen to the text as many times as they needed in the multimedia language lab, at home, or on campus and could adjust the software reading speed. They had to keep a log of the material they have practiced with TTS every week.

Throughout the semester, the instructor served as a facilitator. She responded to individual students' needs, and requests. Every now and then, she would check on the students to see if they were having any problems with the NaturalReader software. The students were given extra credit for using NaturalReader in proportion to the amount of material they practiced throughout the semester.

3.4 Procedures

Before instruction, students in the experimental and control groups took a recognition (vocabulary) pretest and a production (oral reading) pretest. The pretests consisted of questions covering the phoneme-grapheme relationships mentioned in the Theoretical Framework above.

Every 4 weeks, students in the experimental group took an oral reading and a vocabulary test and at the end of the semester (after 12 weeks), both groups took a recognition (vocabulary) posttest and a production (oral reading) posttest. The recognition posttest was part of a vocabulary final exam that consisted of 250 words that covered all of the vocabulary skills and topics studied in the textbook throughout the semester (See section 3.2 above). Specifically, the recognition posttest focused on the following phoneme-grapheme association (correspondence) skills: Recognizing the different pronunciations of the same vowel or vowel digraphs; silent consonants and vowels; hidden sounds; words with the same vowel digraphs but different pronunciation; words with different vowel digraphs but the same pronunciation; pronunciation of foreign words, homophones, homographs; different pronunciations of -ed, and -s; changes that take place when a suffix is adder to a verb, noun or adjective; recognizing suffixes; changing words into adjectives or nouns by adding suffixes; and giving the plural & singular forms, and Past Participle forms.

For the production (oral reading) posttest, a text that the students had never seen before was selected. It was comparable to the reading texts the students had read in their reading textbook in its difficulty level and length. The production posttest was conducted in the language lab. With her head sets on, each student had to read the text out loud and record her reading and note how much time she took to read the text.

The recognition (vocabulary) pre and posttests were blindly graded by the author. The students wrote their ID numbers insteadof

their names. An answer key was used for the vocabulary test. Questions were graded one at a time for all the students. Marks were deducted for spelling mistakes. The total number of errors each student made in the phoneme-grapheme correspondence questions was calculated.

For the production (oral reading) posttest, the author listened to each student an marked the errors that she made on a printed version of the text. The total number of pronunciation errors that the student made in her oral reading was recorded on her printed text.

At the end of the course, all of the students in the experimental group answered an open-ended survey which consisted of the following questions: (1) Did you/did you not like the TTS software? Why (2) Did your pronunciation and word decoding skills improve as a result of using the TTS software? In what ways? (3) Did it make any difference in learning English vocabulary? (4) What problems or difficulties did you face in using the TTS software? How were those problems solved? (5) How often did you use the TTS software? (6) How much time did you spend using and TTS software? (7) Would you use the TTS software in a similar course in the future? Why?

3.5 Data Analysis

For each student, the total number of pronunciation errors she made in the production (oral reading) test and the total number of errors she made on the recognition (vocabulary) test were computed. The production (oral reading) and recognition pre and posttest raw scores were converted into percentages. The mean median, standard deviation, standard error, and range were computed for the pre and posttest scores.

To find out which group made higher gains as a result of the instruction they received, an independent T-test was computed. To find out whether students in the experimental group had made any progress as a result of using the TTS software, a within-group paired T-test was computed using the pre and posttest mean scores.

To find out whether there is a relationship between the students' posttest scores and frequency of using the TTS software, the students' posttest scores were correlated with the number of lessons practiced and amount of practice time with the TTS using the Pearson correlation formula.

3.6 Test Validity and Reliability

The production and recognition posttests are believed to have content validity as they aimed at assessing the students' achievement in word decoding and grapheme-phoneme correspondence skills. The tasks required in the posttest were comparable to those covered in the book and practiced in vocabulary and reading classes. In addition, the production (oral reading) and recognition (vocabulary) test instructions were phrased clearly, and the examinee's task was defined.

Concurrent validity of the production and recognition posttests was determined by establishing the relationship between the students' scores on the production and recognition posttest and their reading and vocabulary course grades. The validity coefficient was .98, and 97 respectively. Concurrent validity was also determined by establishing the relationship between the students' scores on the production and recognition posttests and their scores on the second reading and vocabulary in-term tests. The validity coefficient for the recognition and production tests was .87, 89 respectively.

Since the author was the instructor and the scorer of the production and recognition pre and posttests, estimates of inter-rater reliability were necessary. A 30% random sample of the oral reading recordings and vocabulary answer sheers was selected and double-scored. An instructor who holds a Ph.D. degree in TESOL scored the pre and posttest samples. She followed the same scoring procedures of the oral reading recordings and used the same answer key for the vocabulary test as the author. The scores given by both raters were correlated. The inter-rater correlation was .97, 99 for the production (oral reading) and recognition (vocabulary) post-test respectively. Moreover, examinee reliability was calculated using the Kuder-Richardson formula 21'. The examinee reliability coefficient for the posttest was .71.

4. Results

4.1 Effect of TTS Software on Word Decoding and Pronunciation Accuracy

Tables 1 shows that the typical EFL female freshman student in the experimental group scored higher on the recognition (vocabulary) posttest than the control group (Median = 76 and 66.73% respectively), with lower variations in the recognition test scores among students in the experimental group than the control group scores on the posttest (Standard Deviation = 8.21% and 11.06 respectively). Similarly, the typical student in the experimental group scored higher on the production (oral reading) posttest than the typical student in the control group (median = 77% and 68% respectively) with lower variations among students in the experimental group than the control group (Standard Deviation = 8.39 and 9.17 respectively). This means that students in the

experimental group who used the NaturalReader made higher gains in decoding correctness and pronunciation accuracy than students in the control group who did not. Improvement was noted in the students' reading fluency and pronunciation correctness but not in vocabulary knowledge. Comparisons of experimental students' performance on the pretest, the intermediate tests and posttests showed slow but gradual improvement. Significant improvement was noted after 8 and 12 weeks of practice with NaturalReader.

Since the median and mean scores do not show whether improvement in decoding and pronunciation was significant or not, the experimental and control group recognition (vocabulary) posttest scores and their production (oral reading) posttest scores were compared. Results of the independent T-test revealed a significant difference between the experimental and control group posttest mean scores at the .01 level, suggesting that experimental group students' decoding and pronunciation proficiency significantly improved as a result of using a combination of NaturalReader and traditional in-class vocabulary and reading instruction (recognition T = 12.49; df = 86; production T = 14.89; df = 86; respectively).

Table 2: Distribution of the Recognition (Vocabulary) and Production (Oral Reading) Posttest Scores in Percentages

Groups	Tests	N	Mean	Median	Standard Deviation	Standard Error	Range
Experimental Group	Recognition (Vocabulary)	43	76%	76%	8.21%	1.43	39% - 97%
	Production (Oral Reading)	43	77.74%	77%	8.39%	1.39	32% - 98%
Control Group	Recognition (Vocabulary)	45	66.1%	66.73%	11.06%	1.42	32% - 90%
	Production (Oral Reading)	45	68.62%	68%	9.17%	1.51	38% - 88%

Furthermore, the recognition (vocabulary) and production (oral reading) posttest scores for each student were correlated. The correlation coefficient was .89 and it was significant at the .01 level. This means that students' decoding and pronunciation skills are related as the same grapheme-phoneme correspondences are utilized in both. In other words, a high correlation means a high decoding and pronunciation proficiency and a low correlation means a low decoding and pronunciation proficiency.

4.2 Effect of Usage Frequency on Word Decoding and Pronunciation Accuracy

To find out whether the students made the same gains in decoding and pronunciation as a result of using NaturalReader, the total number of lessons practiced and amount of practice time spent by each student (usage frequency) and by all the students in the experimental group were calculated. Students in the experimental group practiced a total of 4300 vocabulary lessons with a mean of 6 lessons; median = 6 lessons; and range = 1 to 12 lessons per week. The students' practice time per week ranged between 30 minutes and 4.5 hours with a median of 3 hours a week. In the reading course, students in the experimental group practiced a total of 258 reading texts with NaturalReader, with a range between 2 to 6 texts per week; and the practice time ranged between 1.5 and 4.5 hours a week.

The frequency of using NaturalReader by each student was correlated with her posttest score. A significant positive correlation was found between the students' posttest scores and the frequency of using NaturalReader. The correlation coefficient was .84 for the production test and .85 for the recognition test. Both correlations were significant at the .01 level. This suggests that a student's improvement in word decoding and pronunciation correlated with the number of lessons and texts practiced and the amount of time she spent practicing with NaturalReader weekly. This means that high and low usage frequencies of NaturalReader correlated with high and low decoding and pronunciation proficiency levels as measured by the posttests. It can be concluded that using NaturalReader did contribute to the students' overall improvement in decoding and pronunciation.

The variations in practice time and amount of lessons covered by participants in the present study show that NaturalReader has appealed to all the participants. NaturalReader seems to have helped students with a low and average proficiency level more than above-average students who spent less time than their below-average and average peers.

4.3 Effect of NaturalReader on Students' Attitudes

Responses to the post-treatment questionnaire showed positive attitudes towards the NaturalReader decoding and pronunciation self-study. Most students in the experimental group found the NaturalReader useful, practical, and easy to follow, and suitable for their proficiency level. They considered it a new way of practicing and improving their reading, and pronunciation skills in English. They thought that listening to and reading the self-study lessons with NaturalReader were fun. The NaturalReader helped them gain self-confidence as they could practice at their own convenience. At the end of the semester, they were able to read fluently and pronounce the words they have studies correctly. Sara wrote:

"Mimicking words and sentences over and over again helped me remember them. My reading, pronunciation and fluency in English improved greatly".

In addition, NaturalReader motivated many students to practice as it was their first experience using a TTS software. Many reported great satisfaction with NaturalReader as they were able to follow the TTS reader. They developed the habit of engaging in and practicing with NaturalReader on their own and were encouraged to take responsibility for their own practice and their own learning. They could use NaturalReader any time and as many times as they needed. It made the class material easier.

Despite the many benefits of the NaturalReader software, there were some drawbacks such increasing the workload on the part of some students. EFL students who are beginners need to be encouraged to use NaturalReader as it is something new to them. Some students did not know if they were repeating after the software readers correctly. As an instructor, I had to prompt the students to continue to practice with NaturalReader. Some students needed extra help using the TTS software. Hands-on practice had to be provided to those students individually in the office due to lack of time in the classroom. The students also believed that NaturalReader should be used for fun not for credit and serious studying. Many Saudi college students do extra work for grades only. If the NaturalReader or any other technology is not part of tests and grades, they will not participate and will not take it seriously. The author did not have sufficient time in the classroom to brainstorm, monitor or check on the students while working with NaturalReader as the class time was devoted to teaching the lessons and reading texts in the textbook. Other shortcomings are due to the NaturalReader design. The software does not provide the students with feedback when they repeat or read out loud after the TTS reader and whether their pronunciation is correct or faulty.

5. Discussion and Conclusion

A significant difference in decoding and pronunciation proficiency level was found between students who employed the TTS software for extra reading practice outside the classroom and those who did not. Improvement was noted in the students' reading fluency and pronunciation correctness but not in vocabulary knowledge. The TTS software (NaturalReader) proved to be a powerful tool for improving students' decoding and pronunciation skills. NaturalReader raised the good and average student's performance, and the performance of the lowest-performing students as well. This finding is consistent with findings of prior studies using TTS software in reading, listening and vocabulary instruction such as Coleman, Killdare, Bell and Carter (2014); Young, Courtad, Douglas and Chung (2019); Foshage (2019); Baker (2015); Anderson (2009); Mulder, van de Ven, Segers, Krepel, de Bree, de Jong and Verhoeven (2021); Amin (2022); Keelor, Creaghead, Silbert, Breit-Smith and Horowitz-Kraus (2018); Gonzalez (2014); Wood, Browder and Spooner (2020); Van Laere and Braak (2017); Staels and Van den Broeck (2015); Cunningham (2013); Meihami and Husseini (2014) and Eksi and Yesilçinar (2016).

Moreover, the present study revealed positive effects of using NaturalReader on students' attitudes towards practicing reading with TTS software. This finding is also consistent with the findings of a study by Bione, Grimshaw and Cardoso (2016).

To improve students' decoding and pronunciation skills, the present study recommends the following:

- Extending the use of TTS software to other language courses such as listening, speaking, writing and interpreting courses and other college levels (levels 2, 3 & 4).
- To encourage the students to participate, the instructor has to prompt and motivate the students, and rules for using the TTS software should be made clear. The minimum number of lessons can be specified.
- Creating listening material using TTS software (Oktalia & Drajati, 2018; Sha, 2010) and integrating TTS software in lecture slides, with the help of teaching aids such videos, animations (Rughooputh & Santally, 2009).
- Introducing college students with special needs, especially blind students, to the NaturalReader software to be able to read printed material, use a Google Chrome TTS Extension to be able to listen to webpages, online ebooks, Google Docs, and emails. They can also use a NaturalReader App on their mobile to continue listening on their Android or iOS mobile phone (Al-Jarf, 2021a).
- Listening to mobile apps (Al-Jarf, 2020); mobile audiobooks (Al-Jarf, 2021g); watching YouTube and online videos (Al-Jarf, 2022g; Al-Jarf, 2012a; Al-Jarf, 2011); watching TED Talks (Al-Jarf, 2021i); creating podcasts for listening, pronunciation and speaking practice (Al-Jarf, 2021g; Al-Jarf, 2021d) and using technologies such as such as Slido and Padlet (Al-Jarf, 2021c).
- Practicing decoding and pronunciation with vocabulary mobile apps (Al-Jarf, 2022b; Al-Jarf, 2013); online vocabulary tasks (Al-Jarf, 2022d); and reading mobile apps (Al-Jarf, 2012b).
- Making multiple associations in teaching vocabulary and spelling such as showing silent letters, double letters, different consonant graphemes with the same pronunciation, different pronunciation of the same consonant grapheme, different pronunciations of the same vowel digraphs, and vowel digraphs with the same pronunciation and so on (Al-Jarf, 2022a;

Al-Jarf, 2006).

- Practicing decoding, pronunciation, and comprehension with inspirational quotes and linguistic landscapes (Al-Jarf, 2021d; Al-Jarf, 2021h).
- Highly proficient and struggling EFL college readers may engage in extensive reading activities where they can read multicultural children's short stories and fiction from mobile apps and collaborate in mobile ebook reading where good readers help their struggling classmates decode and pronounce difficult words in the text (Al-Jarf, 2015a; Al-Jarf, 2022c; Al-Jarf, 2021b; Al-Jarf, 2012b).
- Installing a variety of TTS software in the department multimedia language labs to help the students practice in their free time and explore the TTS software that is suitable for them (Al-Jarf, 2021e).

Finally, comparisons of Saudi EFL college students' preference for TTS or human reading, preference for desktop/laptop version or TTS mobile apps; and feasibility of TTS software for enlarging EFL students' vocabulary knowledge and improving their writing, listening and reading comprehension; and using TTS software to design supplementary listening material for Saudi EFL college students are still open for further investigation by future researchers in Saudi Arabia.

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References

[1] Al-Jarf, R. (2022a). A multiple-associations approach to teaching technical terms in English for Specific purposes courses. *International Journal of English Language Studies (IJELS), 4*(2), 56-66. DOI: 10.32996/ijels.2022.4.2.5. Google Scholar

[2] Al-Jarf, R. (2022b). Learning vocabulary in the app store by EFL college students. *International Journal of Social Science and Human Research (IJSSHR), 5,* 1, 216-225. DOI: 10.47191/ijsshr/v5-i1-30. http://ijsshr.in/v5i1/30.php **ERIC** ED618472. Google Scholar

[3] Al-Jarf, R. (2022c). Mobile fiction apps for enhancing EFL college students' reading and appreciation skills. *International Journal of Linguistics Studies (IJLS), 2,* 2, 15-23. DOI: 10.32996/ijls.2022.2.2.3. ERIC ED618966. Google Scholar

[4] Al-Jarf, R. (2022d). Online vocabulary tasks for engaging and motivating EFL college students in distance learning during the pandemic and post-pandemic. *International Journal of English Language Studies (IJELS), 4*(1), 14-24. DOI: 10.32996/ijels.2022.4.1.2. **ERIC** ED617510. Google Scholar

[5] Al-Jarf, R. (2022e). Proper noun pronunciation inaccuracies in English by Educated Arabic speakers. *British Journal of Applied Linguistics (BJAL), 4*(1), 14-21. https://doi.org/10.32996/bjal.2022.2.1.3. **ERIC** ED619388 Google Scholar

[6] Al-Jarf, R. (2022f). Student-interpreters' foreign proper noun pronunciation errors in English-Arabic and Arabic-English media discourse interpreting. *International Journal of Translation and Interpretation Studies (IJTIS), 2*(1), 80-90. ERIC ED619940. Doi: 10.32996%2Fijtis.2022.2.1.11. Google Scholar

[7] Al-Jarf, R. (2022g). YouTube videos as a resource for self-regulated pronunciation practice in EFL distance learning environments. *Journal of English Language Teaching and Applied Linguistics (JELTAL), 4*(2), 44-52. https://doi.org/10.32996/jeltal.2022.4.2.4. ERIC ED618965. Google Scholar

[8] Al-Jarf, R. (2021a). Blind Saudi female college students and assistive technologies: A case study. *International Journal of Research in Engineering, IT and Social Sciences (IJREISS), 11*(4), 1-9. ERIC ED613224. http://indusedu.org/pdfs/IJREISS/IJREISS_3780_72724.pdf. Google Scholar

[9] Al-Jarf, R. (2021b). Collaborative mobile ebook reading for struggling EFL college readers. *IOSR Journal of Research & Method in Education (IOSR-JRME), 11*(06), 32-42. Doi: DOI: 10.9790/7388-1106023242. Google Scholar

[10] Al-Jarf, R. (2021c). EFl speaking practice in distance learning during the coronavirus pandemic 2020-2021. *International Journal of Research - GRANTHAALAYAH, 9*(7), 179-196. ERIC ED616739. doi: 10.29121/granthaalayah.v9.i7.2021.4094. ERIC ED615084. Google Scholar

[11] Al-Jarf, R. (2021d). Enhancing EFL freshman students' reading skills with inspirational quotes. *Asian Research Journal of Arts & Social Sciences (ARJASS), 13*(4), 1-11. https://doi.org/10.9734/arjass/2021/v13i430219. ERIC ED620448. https://www.journalarjass.com/index.php/ARJASS/article/view/30219. Google Scholar

[12] Al-Jarf, R. (2021e). Feasibility of digital multimedia language labs for interpreting instruction as perceived by interpreting instructors in Saudi Arabia. *International Journal of Linguistics, Literature and Translation (IJLLT), 4* (4), 70-79. Doi: 10.32996/ijllt.2021.4.4.8. ERIC ED613819. Google Scholar

[13] Al-Jarf, R. (2021f). *How EFL, linguistics and translation instructors engage students in distance learning during the Covid-19 second wave.* TCC Online Conference. Hawaii, USA. April 13-14. Google Scholar

[14] Al-Jarf, R. (2021g). Mobile audiobooks, listening comprehension and EFL college students. *International Journal of Research – GRANTHAALAYAH, 9*(4), 410-423. DOI: 10.29121/granthaalayah.v9.i4.2021.3868. ERIC ED616740. Google Scholar

[15] Al-Jarf, R. (2021h). Teaching English with linguistic landscapes to Saudi students studying abroad. Asian *Journal of Language, literature and Culture Studies (AJL2CS). 4* (3), 1-12. ERIC ED619894

www.journalajl2c.com/index.php/AJL2C/article/view/30148/56568. Google Scholar

[16] Al-Jarf, R. (2021i). TED talks as a listening resource in EFL college classrooms. *International Journal of Language and Literary Studies (ijlls), 2*(3), 256–267. https://doi.org/10.36892/ijlls.v2i3.691. ERIC ED615127. Google Scholar

[17] Al-Jarf, R. (2020). Mobile apps in the EFL college classroom. *Journal for Research Scholars and Professionals of English Language Teaching (JRSP-ELT), 4*(22),1-5. ERIC ED613138. Google Scholar

[18] Al-Jarf, R. (2019a). *EFL freshman students' difficulties with phoneme-grapheme relationships.* 5th VietTESOL International Convention. University of Foreign Languages, Hue City, Vietnam. October 11-12, 2019. **ERIC** ED614068. Google Scholar

[19] Al-Jarf, R. (2019b). Teaching Reading to EFL Arabic Students Online. *Eurasian Arabic Studies, 8,* 57-75. ERIC ED613084. Google Scholar

[20] Al-Jarf, R. (2015a). *Enhancing reading and speaking skills in EFL through multicultural children's short stories*. 7th International Conference, Building Cultural Bridges (ICBCB) titled: Integrating Languages, Linguistics, Literature, Translation, and Journalism into Education.Suleyman Demire lUniversity, Almaty, Kazakhstan. https://doi.org/10.2139/ssrn.3848464 **ERIC ED**610158. Google Scholar

[21] Al-Jarf, R. (2015b). Guide to reading skills for teachers. https://www.researchgate.net/publication/280943939. Google Scholar

[22] Al-Jarf, R. (2013). Learning vocabulary in the app store. Oman 13th International ELT Conference: "Changing Times, Emerging Opportunities for ELT". Sultan Qaboos University, Muscat, Oman. April 16-18. https://www.researchgate.net/publication/356833235. Google Scholar

[23] Al-Jarf, R. (2012a). Online videos for specific purposes. *Journal of Education and Social Research (JESR), 2*(6), 17-21. Italy. https://doi.org/10.5901/ichss-2012-vol-07. Google Scholar

[24] Al-Jarf, R. (2012b). *Reading in the app store*. IATEFL-Hungary 22nd Annual Conference, Eger, Hungary. October 5-7. https://www.researchgate.net/profile/Reima-Al-Jarf/publication/356833385. Google Scholar

[25] Al-Jarf, R. (2011). Helping medical students with online videos. *International Journal of Language Studies (IJLS), 5*(3), 99-110. http://www.ijls.net/pages/volume/vol5no3.html. ERIC ED613074. Google Scholar

[26] Al-Jarf, R. (2010). Spelling error corpora in EFL. US-China Foreign Language. *Sino-US English Teaching,* 7(1), 6-15. DOI:10.17265/1539-8072/2010.01.002. ERIC ED620777. Google Scholar

[27] Al-Jarf, R. (2009a). *Auditory and visual problems of good and poor EFL college spellers.* College of Languages and Translation. https://www.researchgate.net/publication/238599084. Google Scholar

[28] Al-Jarf, R. (2009b). *Maximizing ESL freshman readers' skill with online instruction*. In Roger Cohen (Ed.) Explorations in Second Language Reading. Pp. 133-144 TESOL. ERIC ED523349. Google Scholar

[29] Al-Jarf, R. (2008). *Listening-spelling strategies in EFL Arab college students*. College of Languages of Translation, King Saud University Seminars. Google Scholar

[30] Al-Jarf, R. (2007a). *Faulty strategies of EFL freshman spellers*. TESOL Arabia 1999 Conference "Unity and Diversity". Al-Ain, UAE. Google Scholar

[31] Al-Jarf, R. (2007b). *Impact of blended learning on EFL college readers*. IADIS International Conference on e-Learning, Lisbon. Google Scholar

[32] Al-Jarf, R. (2006). *Making connections in vocabulary instruction*. 2nd ClaSic Conference proceedings. Singapore. ERIC ED497939. Google Scholar

[33] Al-Jarf, R. (2005a). The effects of listening comprehension and decoding skills on spelling achievement of EFL freshman students. English language and literature Education. *Journal of the English Language Teachers in Korea (ETAK), 11*, 2. Google Scholar

[34] Al-Jarf, R. (2005b). The relationship among spelling, listening and decoding skills in EFL freshman students. *English Language & Literature Teaching, 11(2), 35-55.* Google Scholar

[35] Al-Jarf, R. (1999). *Listening-spelling strategies of freshmen students*. TESOL Arabia Conference titled "Unity and diversity. Google Scholar

[36] Amin, E. (2022). Using repeated-reading and listening-while-reading via text-to-speech apps in developing fluency and comprehension. *World Journal of English Language, 12*(1)211-220.

[37] Anderson, S. (2009). *Supporting reading comprehension of at-risk pre-adolescent readers through the use of text-to-speech technology paired with strategic instruction*. Ph.D. Dissertation, University of Kansas, USA. **ERIC** ED512886.

[38] Baker, F. (2015). Emerging realities of text-to-speech software for nonnative-English-speaking community college students in the freshman Year. *Community College Journal of Research and Practice*, 39(5)423-441.

[39] Bione, T., Grimshaw, J. & Cardoso, W. (2016). *An evaluation of text-to-speech synthesizers in the foreign language classroom: learners' perceptions*. *Research-publishing.net*, 23rd EUROCALL Conference, Limassol, Cyprus. **ERIC** ED572021.

[40] Bruno, L., Lewis, A., Kaldenberg, E., Bahr, P. A. & Immerfall, J. (2020). Direct instruction of text-to-speech software for students with intellectual disability. *Education and Training in Autism and Developmental Disabilities*, 55(4), 424-437.

[41] Brunow, D. & Cullen, T. (2021). Effect of text-to-speech and human reader on listening comprehension for students with learning disabilities. *Computers in the Schools*, 38(3), 214-231.

[42] Cardoso, W. (2018). Learning L2 *Pronunciation with a Text-to-Speech Synthesizer. Research-publishing.net.* 26th EUROCALL Conference, Jyväskylä, Finland. **ERIC** ED590634.

[43] Cardoso, W., Smith, G. & Fuentes, C. (2015). *Evaluating text-to-speech synthesizers*. Research-publishing.net. 22nd EUROCALL Conference, Padova, Italy. **ERIC** ED564181.

[44] Chiang, H. (2019). A comparison between teacher-led and online text-to-speech dictation for students' vocabulary performance. *English Language Teaching*, 12(3)77-93.

[45] Coleman, M, Killdare, L. K., Bell, S. & Carter, A. (2014). Comparing the impact of rates of text-to-speech software on reading fluency and comprehension for adults with reading difficulties. *Learning Disabilities: A Multidisciplinary Journal*, 20(2), 87-97.

[46] Craig, S. D. & Schroeder, N. L. (2019). Text-to-speech software and learning: investigating the relevancy of the voice effect. *Journal of Educational Computing Research*, 57(6)1534-1548.

[47] Cunningham, R. (2013). *The effects of word prediction and text-to-speech on the writing process of translating.* Ph.D. Dissertation, University of Missouri, Saint Louis, USA. **ERIC** ED553604

[48] Eksi, G. Y. & Yesilçinar, S. (2016). An Investigation of the Effectiveness of Online Text-to-Speech Tools in Improving EFL Teacher Trainees' Pronunciation. *English Language Teaching*, 9(2), 205-214.

[49] Foshage, S. (2019). *The impact of text-to-speech software on reading level of high school students.* Ed.D. Dissertation, Missouri Baptist University. ERIC ED598799

[50] Gonzalez, M. (2014). The effect of embedded text-to-speech and vocabulary ebook scaffolds on the comprehension of students with reading disabilities. *International Journal of Special Education*, 29(3), 111-125.

[51] Harvey, J. (2013). Text-to-speech and reading while listening: reading support for individuals with severe traumatic brain injury. Ph.D. Dissertation, University of Nebraska, Lincoln, USA. **ERIC** ED559597.

[52] Keelor, J., Creaghead, N., Silbert, N., Breit-Smith, A. & Horowitz-Kraus, T. (2018). Language, reading, and executive function measures as predictors of comprehension using text-to-speech. *Reading & Writing Quarterly*, *34*(5)436-450.

[53] Meihami, H. & Husseini, F. (2014). Bringing TTS software into the classroom: The effect of using text-to-speech software in teaching reading features. *Teaching English with Technology*, *14*(1)23-34.

[54] Mulder, E., van de Ven, M., Segers, E., Krepel, A., de Bree, E., de Jong, P. F. & Verhoeven, L. (2021). Word-to-text integration in English as a second language reading comprehension. *Reading and Writing: An Interdisciplinary Journal*, *34*(4)1049-1087.

[55] Oktalia, D. & Drajati, N. A. (2018). English teachers' perceptions of text to speech software and google site in an EFL classroom: What English teachers really think and know. *International Journal of Education and Development using Information and Communication Technology*, *14*(3),183-192.

[56] Rughooputh, S. & Santally, M. I. (2009). Integrating text-to-speech software into pedagogically sound teaching and learning scenarios. *Educational Technology Research and Development*, *57*(1) p131-145.

[57] Sha, G. (2010). Using TTS voices to develop audio materials for listening comprehension: A digital approach. *British Journal of Educational Technology*, *41*(4), 632-641.

[58] Staels, E. & Van den Broeck, W. (2015). Orthographic learning and the role of text-to-speech software in Dutch disabled readers. *Journal of Learning Disabilities*, *48*(1), 39-50.

[59] Van Laere, E. & Braak, J. (2017). Auditory support in linguistically diverse classrooms: factors related to bilingual text-to-speech use. *Journal of Computer Assisted Learning*, *33*(1)79-95.

[60] Wood, L., Browder, D. & Spooner, F. (2020). Teaching listening comprehension of science e-texts for students with moderate intellectual disability. *Journal of Special Education Technology*, *35*(4), 272-285.

[61] Young, M., Courtad, C. Douglas, K. H. & Chung, Y. (2019). the effects of text-to-speech on reading outcomes for secondary students with learning disabilities. *Journal of Special Education Technology*, *34*(2), 80-91.