Using Haptic Virtual Reality to Remedy Preparatory School Pupils' EFL Reading and Writing Difficulties

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Blind Reviewed Journal

المستخلص

هدفت الدراسة الحالية الي علاج صعوبات القراءة والكتابة باللغة الانجليزية لدي تلاميذ المرحلة الاعدادية من خلال استخدام الواقع الافتراضي اللمسي . تكونت عينة الدراسة من ٦٤ تلميذا تم اختيارهم بعد تطبيق اختبار لقياس صعوبات القراءة والكتابة باللغة الانجليزية على جميع تلاميذ الصف الثاني الاعدادي من مدرسة الوعي القومي الاعدادية بنين بشبين الكوم محافظة المنوفية خلال الفصل الدراسي الاول للعام الدراسي ٢٠٢٢/٢٠٢١ . تم تقسيم العينة الي مجموعة تجريبية (٣٢) تلميذا ومجموعة ضابطة (٣٢) تلميذا. تم تدريس المجموعة التجريبية من قبل الباحثة من خلال استخدام الواقع الافتراضي اللمسي، بينما تم تدريس المجموعة الضابطة بالطريقة المعتادة. اعتمدت الدراسة علي التصميم شبه التجريبي. قامت الباحثة باعداد اختبار لصعوبات القراءة والكتابة تم تطبيقه قبليا وبعديا علي مجموعتي الدراسة. كما صممت الباحثة برنامج قائم علي الواقع الافتراضي اللمسي لعلاج صعوبات القراءة والكتابة باللغة الانجليزية وكشفت النتائج ان استخدام الواقع الافتراضي اللمسي له تاثيرايجابي في علاج صعوبات القراءة والكتابة باللغة الانجليزية لدي تلاميذ الصف الثاني الاعدادي .حيث قلل صعوبات قراءة وكتابة بعض الكلمات الشائعة وصعوبات القراءة بطلاقة والقراءة السريعة الغير صحيحة التي نتج عنها تحسن في الفهم والاستيعاب. ايضا عالج صعوبات تخطي الكلمات صعوبات قراءة الكلمات متعددة المقاطع وصعوبات في شكل وحجم الحروف وصعوبات المسافة بين الاحرف مما نتج عنه تحسن كبير في الاملاء والكتابة بدقة ، ولقد كانت النتائج مؤكدة ومدعمة للفروض وهذا يعكس التقدم المحرز في القراءة و الكتابة لدي التلاميذ نتيجة استخدام الواقع الافتراضي اللمسي ويوصي بجذب انتباه المعلمون ومصممي المناهج الي اهمية استخدام الواقع الافتراضي اللمسي في تعلم اللغة الانجليزية بصفة عامة وعلاج صعوبات القراءة والكتابة باللغة الانجليزية بصفة خاصة.

الكلمات المفتاحية: الواقع الافتراضي اللمسي – صعوبات القراءة والكتابة .

Abstract

The current study aimed at investigating the effect of using haptic virtual reality to remedy preparatory school pupils' EFL reading and writing difficulties. To answer the questions of the study, the researcher adopted the quasi-experimental design. The participants included (64) pupils selected after administering a reading and writing difficulties test to all second preparatory stage pupils from El Waay El Kawmy Prep School, Shebin El Kom Educational Zone, Menofia Governorate. They were assigned to one experimental group and a control group. Each group consisted of thirty -two pupils. The instrument of the study consisted of a pre- post-test in reading difficulties and writing difficulties. Also, she constructed a program based on haptic virtual reality to remedy reading and writing difficulties. The experimental group was taught through haptic virtual reality technology and the control group received regular instruction. The treatment took place during the first semester of the academic year 2021/2022. Then the data of the study were statistically analyzed. The findings revealed that haptic virtual reality technology had a large impact on remedying second year preparatory school pupils' reading and writing difficulties, namely it decreased the difficulties of reading and writing some high frequency words, difficulties of reading fluently and incorrect rapid reading that resulted in a great improvement in comprehension and understanding. It remedied the difficulties of skipping words, difficulties of reading some poly syllabic words, difficulties with shape and size of letters and difficulties of space between letters that resulted in improvement in dictation and accurate writing. This study also suggested that further researches should be conducted on the use of haptic virtual reality in remedying reading and writing difficulties in particular.

Key words: Haptic virtual reality, Reading and Writing difficulties.

1.1. Introduction

English is considered the international language that is used in all fields such as technology, economy, politics, and education. English language is essential to learning. A reading disability is evidenced by difficulties with accurate and or fluent word recognition and decoding skills. These deficits impact the person's ability to reason with language, such as comprehending and deriving meaning from what is read. Reading difficulties may be characterized by: a) substitution of a letter or a word instead of others; b) omission, insertion phonemes to words he reads; c) difficulties reading some polysyllabic words; d) his reading was not fluent (difficulties in fluency); e) often skipped words; f) couldn't recognize simple high frequency words (in, at, was…..); g) incorrect rapid reading; h) lack of comprehension and understanding.

Teaching English writing to Arab learners has many challenges. Therefore, they are more prone to committing errors. Writing difficulties include the following: a) Having troubles with shape and size of the letter, b) Having troubles with space between letters, c) Having troubles writing some high frequency word, d) Omission, substitution, and insertion of some letters in dictation, e) Misspelling in dictation, f) Punctuation errors and grammar and g) Difficulties in discriminating similar sounds.

In the language classroom, technology is an effective way to enhance the students' learning process and arousing their interest in learning the concept through multi- sensory approach. (Vaughn:2018). A multisensory approach, also known as VAKT (visual-auditory-kinesthetic-tactile) implies that students learn best when information is presented in different modalities or using the four modalities. It is one that integrates sensory activities. The English teachers have to use the available technologies in an effective way to improve the reading ability of the students. (Manig:2018).

Researchers have recognized virtual reality's potential in accessibility and developed various virtual reality systems for training and rehabilitation for people with different disabilities, such as dyslexia. Using the haptic modality enabled children to learn more efficiently in reading. The kinesthetic feeling, which muscles are responsible for, researchers think to simulate. This feeling, which researchers seek to simulate using different

methods, cannot reach high level in education but by connecting it with psychological theories from one part and supplying the most modern technologies from the other part. (Fargon:2017).

Through reviewing literatures and related studies about reading and writing difficulties it is that there is an apparent gap in research when it comes to technology- enhanced multi- sensory education, and where research does exist, it is limited to its use in learning how to read or with reference to its use in learning how to read or with reference to assisted. Most available research focuses on dyslexia and a manual approach to multi- sensory education. (Johann:2016).

Virtual reality has recently gained importance as an innovation to enhance English language learning environments. It provides learners with a first-person experience by enabling them to be present virtually in the events and environments related to the topics that they study. Virtual reality, thus, provides the students with an interactive and immersive language learning environment. There are different virtual reality systems like HTC vive, Google Cardboard, Samsung Gear VR, Oculus Rift, Oculus Go and Oculus Quest, which can provide immersive language learning. (Ahmet, 2020).

1.2. Context of the problem

The problem is derived from the following: The researcher's experience in teaching English as a foreign language where she observed while teaching the low level of students in reading and writing skills, reviewing literature and previous studies revealed that the pupils encounter difficulties in reading as (Ebere, 2016; Ahmet, 2020; Wanzek, 2020; Gharaibeh,2021; Habib,2021; Hanevik,2022; Harris, 2022; Vanden Boer, 2022 and Wanzek, 2022) and all of them confirmed that EFL pupils lack the ability to read correctly. Furthermore, they revealed that the pupils encounter difficulties in writing as (Adas, 2013; Akramovna, 2020; Chung, 2020; Al- Onizat,2021; Ghulamuddin, 2021; Ismiati, 2021; Nobel, 2021; Marbun, 2022 and Wau, 2022) and all of them confirmed that EFL pupils lack the ability to write correctly.

To document this problem, the researcher conducted a pilot study where she prepared a reading and writing skills test. The test aimed at revealing the pupils' reading and writing difficulties, [namely: substitution

of a letter or a word instead of others, omission, insertion phonemes to words he reads, difficulties reading some polysyllabic words, his reading was not fluent (difficulties in fluency), often skipped words, couldn't recognize simple high frequency words (in, at, was…..), incorrect rapid reading, lack of comprehension and understanding, having troubles with shape and size of the letter, has troubles with space between letters, has troubles writing some high frequency word, omission, and difficulties in discriminating similar sounds substitution, and insertion of some letters in dictation, misspelling in dictation, punctuation errors and grammar, The test consisted of 15 questions, each measured a difficulty] .The test was administered to a group of (20) pupils from Elwaay- Elkawmy Preparatory School, Shebin Elkom, Menofeia Governorate. The results of the pilot study are shown in table (1).

Table (1) Means and percentages of pupils' scores in the pilot study

Difficulties	Number of pupils with difficulties	percentage	Total score	Questions number
Reading difficulties				
Substitution of a letter or a word instead of others.	**17**	**85%**	**5**	**5**
Omission, insertion phonemes to words he reads.	**16**	**80%**	**5**	**5**
Difficulties reading some polysyllabic words.	**18**	**90%**	**5**	**5**
His reading was not fluent (difficulties in fluency).	**19**	**95%**	**5**	**5**
Often skipped words.	**15**	**75%**	**5**	**5**
Couldn't recognize simple high frequency words (in, at, was…..).	**18**	**90%**	**5**	**5**
Incorrect rapid reading.	**16**	**80%**	**5**	**5**
Lack of comprehension and understanding.	**18**	**90%**	**5**	**5**
Total			**40**	**40**
Writing difficulties				
Has troubles with shape and size of the letter.	**16**	**80%**	**5**	**5**

Has troubles with space between letters.	**17**	**85%**	**5**	**5**
Has troubles writing some high frequency word.	**18**	**90%**	**5**	**5**
Omission, substitution and insertion of some letters in dictation.	**17**	**85%**	**5**	**5**
Misspelling in dictation.	**16**	**80%**	**5**	**5**
Punctuation errors and grammar.	**18**	**90%**	**5**	**5**
Difficulties in discriminating similar sounds.	**19**	**95%**	**5**	**5**
Total			**35**	**35**

The results indicated that the pupils' mean score in substitution of a letter or a word instead of others (85%), omission, insertion phonemes to words he reads (80%), difficulties reading some polysyllabic words (90%), his reading was not fluent (difficulties in fluency). (95%), often skipped words (75%), couldn't recognize simple high frequency words (in, at, was…..) (90%), incorrect rapid reading (80%), lack of comprehension and understanding (90%), has troubles with shape and size of the letter (80%), has troubles with space between letters (85%), has troubles writing some high frequency word (90%), omission, substitution, and insertion of some letters in dictation (85%), misspelling in dictation (80%), punctuation errors and grammar (90%), difficulties in discriminating similar sounds (95%) reflecting that they had reading and writing difficulties. The findings revealed that most of the pupils had difficulties in reading and writing. And this is evidence of their reading and writing difficulties mentioned above.

1.3. Statement of the problem

Based on the literature review, and the results of the pilot study, the problem can be stated as follows: Second year preparatory school pupils have some reading and writing difficulties. That is why the current study attempted to use haptic virtual reality in remedying preparatory school pupils' reading and writing difficulties.

1.4. Aim of the study

The current study aimed at remedying EFL reading and writing difficulties of second year preparatory school pupils through using haptic virtual reality.

1.5. Questions of the study

The current study attempted to answer the following main question:

What is the effect of haptic virtual reality on remedying reading and writing difficulties of preparatory school pupils?

This main question is divided into the following sub questions:

1- What are EFL reading and writing difficulties of second year preparatory school pupils?
2- How far is haptic virtual reality effective in remedying reading difficulties of second year preparatory school pupils?
3- To what extent is haptic virtual reality effective in remedying EFL writing difficulties of second year preparatory school pupils?

1.6. Hypotheses of the study

To achieve the aim of the study, the following hypotheses were set:

1- There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in the overall reading skills post- test in favor of the experimental group.
2- There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in each of the reading skills post- test in favor of the experimental group.
3- There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in the overall writing skills post- test in favor of the experimental group.
4- There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in each of the writing skills post- test in favor of the experimental group.

1.7. Definition of terms

1- Haptic virtual reality

The researcher operationally defined it as "a set of techniques related to the creation of a virtual reality in which the sense of touch, sight, hearing and movement are integrated to give a realistic embodiment of the virtual objects, thus facilitating reading and writing for those with reading and writing difficulties of second preparatory pupils.".

2- Reading Difficulties

The researcher defined it operationally as "the difficulties that second year preparatory pupils face and they include substitution of a letter or a word instead of others, omission, insertion phonemes to words he reads, difficulties reading some polysyllabic words, his reading was not fluent (difficulties in fluency), often skipped words, could not recognize simple high frequency words (in, at, was…..), incorrect rapid reading, lack of comprehension and understanding.

3- Writing Difficulties

The researcher defined it as "the difficulties that second year preparatory in writing skill pupils face and they include troubles with shape and size of the letter, troubles with space between letters, troubles writing some high frequency word, omission, and difficulties in discriminating similar sounds substitution, and insertion of some letters in dictation, misspelling in dictation, punctuation errors and grammar.".

2. Review of Literature

2.1. Reading Difficulties

2.1.1. Definition of Reading Difficulties

More than two-thirds of students with disabilities enter the secondary grades with established reading difficulties (National Center for Education Statistics, 2019). Many middle school students with reading difficulties continue to present difficulties in foundational reading skills (word reading or reading fluency) in addition to challenges comprehending complex texts. (Capin, 2022).

Struggling readers often have difficulties with multisyllable words. These words are often critical to understanding the meaning of texts, and multisyllable word reading instruction has been found to be effective in improving the decoding skills of struggling readers. To implement, teach students to break words into syllables using knowledge of syllable types or word parts (e.g., prefixes, suffixes, roots) and model flexible application of decoding strategies during word reading. (Toste et al, 2019).

Students with reading difficulties are more likely to struggle with fluent oral reading than their peers typically achieving Moreover, reading

fluency difficulties often negatively affect other reading skills in this population, such as reading comprehension and vocabulary acquisition. (Zimmermann, 2021).

In fact, there are several definitions of reading difficulties. The following are some of them:

Reading difficulty occurs to students with average or above average intelligence studying under normal conditions which is a solid ground the current study uses to base sample selection. Furthermore, defining the aspect of weakness (word-recognition, reading comprehension, or both) is also critical as it can make the process of diagnosis and intervention much easier. (El-Assi, 2018).

2.1.2. Characteristics of reading difficulties

Supriatna (2021) mentioned that there are several characteristics of reading difficulties, including:

1. have trouble reading, slow and have poor writing.
2. like to reduce or add words while reading.
3. Experiencing errors when reading such as the letter "p" is considered "q" and the letter "b" is considered "d".
4. often reversing the words.
5. often accompanied by misspellings.

2.1.3. The relationship between reading difficulties and multisensory technique

The multisensory technique is an alternative used as reference material for teachers to improve the reading skills of dyslexic sufferers. Multisensory Techniques that can be used include:

1) Reading and Spelling Training.
2) Visual Technique.
3) Auditory Technique.
4) Tactile Technique.

The reading and spelling focus on maintaining relationships between sounds and symbols starts with a single letter and continues with consonant combinations, vowel continuation, and complex letter groupings. The Visual Technique can begin by using a picture card with the word written on the bottom (flashcard). Auditory technique for children who have difficulty with sound problems, teach a pair of short phrases and ask the child to say which word is correct. In addition, children with dyslexia will

have the best learning by touch, so it is essential to incorporate this learning style into the instruction as a tactile technique. (Supriatna, 2021).

2.2. Writing Definition

2.2.1. Definition of writing difficulties

Because writing is a complex and difficult skill, a lot of learners face some difficulties during practicing writing. These difficulties appear in the sub-skills of writing such as: punctuation, spelling, grammar and handwriting mechanics. The students with learning difficulties are not motivated to write in English for a number of possible reasons. First, physical condition means the atmosphere in class. Particularly, they are taught in a large class; overcrowded with too many students. Second, their English teachers use traditional teaching techniques such as methods of teaching English included the medium of instructions. Therefore, this lack of motivation can have a strong negative effect on the students' development in writing English and their low motivational intensity contribute to the students' vocabulary problems in writing (Mohamed, 2021).

When learners face problems or difficulties in learning writing, the term dysgraphia appeared in the field of EFL. Dysgraphia refers to disability in spelling, handwriting and written composition. Dysgraphia is a brain-based learning disability that affects fine motor skills, particularly writing, through adulthood. It is more common in individuals with ADHD (Frye,2020).

2.2.2. Characteristics of writing difficulties

Learners with learning difficulties suffer from problems in learning and face difficulties in writing skills. They face problems in spelling, handwriting, grammar and written composition. Frye (2020) mentioned some characteristics of writing difficulties as follows:

- Trouble forming letters or spacing words consistently.
- Awkward or painful grip on a pencil.
- Difficulty following a line or staying within margins.
- Trouble with sentence structure or following rules of grammar when writing, but not when speaking.
- Difficulty organizing or articulating thoughts on paper.
- Pronounced difference between spoken and written understanding of atopic.

The characteristics of writing difficulties include the following:

- Variably shaped and poorly formed letters
- Excessive erasures and cross-outs
- Poor spacing between letters and words
- Letter and number reversals beyond early stages of writing
- Awkward, inconsistent pencil grip
- Heavy pressure and hand fatigue
- Slow writing and copying with legible or illegible handwriting

2.3. Haptic virtual reality

2.3.1. The origin of "haptic"

The origin of the word "haptic" dates back to 1931. Its origin is in Greek and emerged from the word "Haptikos" and "haptesthai", which meant touch. (Pala, 2019). He mentioned that the word haptics drives from the Greek word "haptein" meaning "to fasten" and generally refers to the sense of touch. He added that the term "Haptics" was first introduced in 1931 and its origins can be traced back to Greek words "haptikos" meaning able to touch and "haptesthai" which translated to be able to lay hold of. Today the term in its broadest sense, encompasses the study of touch and the human interaction with the external environment via touch.

As a matter of fact, the term haptic is derived from the Greek word "apitiko" which signifies the sense of touch. Recently, this term comes to the foreground for technological aspects to refer to the science of manipulation and sensing of particular environment through touch. (Minopoulos, 2019).

3.3.2. Definition of Haptic

The term haptic is often used to refer both to a sensory perception and to human machine interfaces. In the former sense it relates to the integration of touch and proprioceptive cues, with other sensory information. (Webb,2021).

Mantovani (2019, 24) stated that the word haptic comes from the Greek word haptikos: "able to touch or grasp" and it has gained the meaning of "Relating to the sense of touch, in particular relating to the perception

and manipulation of objects using the senses of touch and proprioception". With haptics we mean the process of recreating the sense of touch by applying forces, vibration or motion to the user.

2.3.3. The significance of haptic

In education, the use of haptic devices should be particularly beneficial in many situations where it is important for the student to experience a realistic simulation of forces. However, with most current virtual reality displays, if a user tries to touch a virtual object there is not any non- visual cue to let the user know that the object is in contact with the user's hand. Also, there may not be a mechanism to keep the user's virtual hand from passing through an object viewed using a virtual reality display. (Barfield, 2019).

2.3.4. The use of haptic technology in education

The main benefit of haptic technology for education is that it increases the realism of simulations by providing force or tactile feedback to the user. With haptic display technology, the student can touch the surface of a virtual object, feel any forces that the virtual object may exert on other objects displayed in the simulation. The use of haptic technology should be beneficial for arrange of tasks associated with the process of learning. (Barfield, 2019).

2.3.5. The significant of haptic technology

Kinesthetic learners' endeavor to learn concepts through reading and listening, therefore, haptic technology is a significant opportunity offered to those kinesthetic learners. Learning environment that is presented by means of visual and auditory methods can be enriched by including the sense of touch in the environment. Haptics enables students to touch and explore objects actively, thereby helping the learning process. With the help of haptics students can feel objects tactually, thus it is possible for them to overcome conceptual barriers regarding reading and writing. (Pala, 2019).

2.3.6. Virtual Reality

In essence, virtual reality refers to any technology that creates a simulated experience of being present in a virtual environment that replaces the physical world. This sense of (virtual) presence is a key concept in VR and is what distinguishes this technology from others along the so-called mixed reality spectrum: someone playing a traditional video game, for example, or even reading a captivating book, may very well become

immersed in it but is unlikely to feel physically transported to the locale depicted on their computer screen. Experiencing presence in VR is a powerful perceptual illusion, yet an illusion nonetheless: the environment may indeed prompt overt cognitions like "I know this is not real"—as individuals undergoing VR exposure therapy often think and say aloud as a safety behavior—yet this is done after the same user has already acted congruent with the environment, thereby demonstrating that it is nonetheless perceived as real. (Lindner, 2021).

2.3.7. Features of virtual reality

Tiffany (2018) stated some of the features of virtual reality that can facilitate situated learning include:

1- The control and modifications abilities of the environment.
2- The contextually rich and highly realistic nature of the learning environment.
3- The flexibility of allowing users to adjust the difficulty of the problem, and thereby, building their knowledge and skills.
4- The opportunity for multiply practices, including inter disciplinary collaborations and practices where different variables are enforced.

2.3.8. Haptic virtual reality

Over the last several years, a significant evolution of methods and techniques of virtual reality (VR) as well as haptic technologies and devices can be observed. Beside influencing the sense of sight and hearing, an immersive simulation can be supplemented with tactile feedback that significantly affects the degree of immersion. Tactile feedback is achieved using haptic devices with a force feedback effect (e.g., phantom, glove, manipulator) equipped with a number of sensors, which record parameters like directions and velocity of user's movement. User is given an opportunity to touch a virtual object, but also can manipulate this objects space and shape its geometry.

A typical system consists of central computer unit (hardware + software) and an external haptic device. Virtual reality can deliver outstanding advantages as educational technology and learning environment. Through several 3D applications that take advantage of haptic to improve multisensory learning are much rare when properly designed, it can support more effective multimedia instruction and collaboration

learning than non-immersive, or 3D system offering physical tangibility. The system integrates the multiple advantage of immersive multisensory, and tactile learning. VR technology provides an immersive learning experience that integrates several effective learning approaches including multimedia and multisensory instruction, haptics, and gamification of learning. (Edwars,2018).

2.3.9. Oculus Quest

To create the perceptual illusion, special hardware is required. Until only a few years ago, such hardware was inaccessible, expensive, and required trained professionals to both develop software for and use. While it is possible to transform a (restricted) physical environment into a virtual one by projecting interactive images onto the walls- a so-called CAVE setup- developments in head-mounted display (HMD) technology has made this latter VR approach the dominant one, especially with the release of consumer VR platforms that are all of the HMD kind. Modern VR HMDs come in two versions: mobile devices, either freestanding or smartphone-based, and tethered devices. Mobile devices offer simplicity of use and do not physically constrain the user, yet are computationally limited and must also be recharged. Tethered devices require a high-end computer or gaming console to run, connected via cable. It should be noted that wireless tethering is being developed and will likely be released in the years to come and that VR devices like the Oculus Quest can now run in both mobile and tethered modes, offering more computational power in the latter. (Lindner, 2021).

2.3.10. Oculus Quest 2 in Education

Oculus quest 2 is an all-in-one apparatus that foregoes physical or digital connectivity to external PCs. One of the principal benefits of it, therefore, is the freedom of usage given to the user. The onboard Oculus Insight tracking system translates user feedback into the virtual space, regardless of real-world location or play area boundaries, without the need for external sensors or wires. Further, player input is recorded using dual Oculus Touch controllers that allow the user to pick up, hold, and relinquish virtual objects with intuitive, realistic precision and haptic-kinesthetic feedback (see Oculus Quest, 2019). (McGee, 2021).

It has been noted that certain virtual reality activities increase the degree and quality of peer-to-peer and student-to-content interactions. This

synergy further enhances self-reflection and motivation, while also broadening communities of practice on both the local and remote levels. In this communal context, students explore and negotiate linguistic features in peer-supported environments that minimize negative affective factors. (Smith, 2021).

3. Method

3.1. Design of the Study

The current study adopted the descriptive analytical design in reviewing literature. It also adopted the quasi- experimental design where the experimental group and the control group were pre- post- tested on their reading and writing difficulties. Experimentation took place during the first semester of the academic year 2021/2022 for eleven weeks.

3.2. Participants of the study

Sixty-eight pupils from El Waay El Kawmy Prep School, Shenin El Kom, Menofia Governorate participated in the study during the academic school year 2021/2022. They were assigned to two groups, a control group (N= 34) and an experimental group (N = 34). The researcher selected Waay El Kawmy Prep School for the following reasons:

1. The researcher works as a school principal at this school which enabled her to teach both the control group and the experimental groups.
2. The school is equipped with a computer lab and facilities that helped to carry out the experimental procedures easily.
3. The administration and the colleagues were supportive and cooperative.

The participants' ages ranged from fourteen to fifteen years. These pupils have been studying English for six years at the primary stage and one year at the preparatory stage. In addition, participants were to a great extent equivalent in their entry level (pre- reading and writing statistics).

To control variables prior to implementing the treatment, the results of the pre- post-test were subjected to statistical treatment to find whether there was a statistically significant difference between the control and the experimental groups in terms of reading and writing difficulties before experimentation. The "t- test" for the independent samples was used, and the results are shown in the following table: **Table (2):** ***T –test of the pre- test comparing the control and the experimental***

groups in overall reading and writing difficulties and each of the reading difficulties.

Difficulties	The group	N	Means	S. D	D.f	T - value	Sig.
Overall Reading and writing difficulties	Experimental	34	11.7353	3.42282	66	0.407	No Sig.
	Control	34	12.1176	4.27654			
1- Difficulties reading some poly syllabic words.	Experimental	34	2.3235	1.12062	66	0.266	No sig.
	Control	34	2.2353	1.57747			
2- Difficulties reading fluently.	Experimental	34	2.3235	0.91189	66	1.099	No sig.
	Control	34	2.0294	1.26695			
3- Difficulties of recognizing simple high frequency words.	Experimental	34	1.3824	1.04489	66	0.424	No sig.
	Control	34	1.5000	1.23705			
4- Difficulties of incorrect rapid reading.	Experimental	34	2.2353	1.01679	66	0.192	No sig.
	Control	34	2.1765	1.46620			
5- Difficulties of skipping words.	Experimental	34	1.4706	0.96091	66	1.677	No sig.
	Control	34	1.9412	1.32439			
6- Difficulties of substitution of a letter or a word instead of others.	Experimental	34	2.0000	1.04447	66	0.719	No sig.
	Control	34	2.2353	1.59656			
7- Difficulties of comprehension and understanding	Experimental	34	2.3232	1.5644	66	0.766	No sig.
	Control	34					

The above table shows that there was no statistically significant difference between the experimental and the control groups' mean scores on each of the pre reading difficulties test. Taking each difficulty separately, the t-test value in the first reading difficulty, Difficulties reading some poly syllabic words, t = 0.266, which is not statistically significant at 0.01 level of confidence. In the second reading difficulty, Difficulties reading fluently, t = 1.099, which is not statistically significant at 0.01 level of confidence. In the third reading difficulty, Difficulties of recognizing simple high

frequency words, t = 0.424, which is not statistically significant at 0.01 level of confidence. In the fourth reading difficulties, Difficulties of incorrect rapid reading, t =0.192, which is not statistically significant at 0.01 level of confidence. In the fifth reading difficulty, Difficulties of skipping words, t =1.677, which is not statistically significant at 0.01 level of confidence. In the sixth reading difficulties, Difficulties of substitution of a letter or a word instead of others, t =0.719, which is not statistically significant at 0.01 level of confidence. In the seventh reading difficulties, Difficulties of comprehension and understanding, t =0.766, which is not statistically significant at 0.01 level of confidence.

Table (3): ***T –test of the pre- test comparing the control and the experimental groups on each of the writing difficulties.***

Reading difficulties	The group	N	Means	S. D	D.f	T - value	Sig.
1- Difficulties with shape and size of the etter.	Experimental	34	2.3235	1.12062	66	0.266	No sig.
	Control	34	2.2353	1.57747			
2- Difficulties with space between letters.	Experimental	34	2.3235	0.91189	66	1.099	No sig.
	Control	34	2.0294	1.26695			
3- Difficulties of writing some high frequency words.	Experimental	34	1.3824	1.04489	66	0.424	No sig.
	Control	34	1.5000	1.23705			
4- Difficulties of discriminating similar sounds	Experimental	34	2.2353	1.01679	66	0.192	No sig.
	Control	34	2.1765	1.46620			
5- Difficulties of misspelling in dictation.	Experimental	34	1.4706	0.96091	66	1.677	No sig.
	Control	34	1.9412	1.32439			
6- Difficulties with punctuation and grammar.	Experimental	34	2.0000	1.04447	66	0.719	No sig.
	Control	34	2.2353	1.59656			

The above table shows that there was no statistically significant difference between the experimental and the control groups' mean scores on each of the pre writing difficulties test. Taking each difficulty separately, the t-test value in the first writing difficulty, Difficulties with shape and size of the letter, t = 0.266, which is not statistically significant at 0.01 level of confidence. In the second writing difficulty, Difficulties with space between

letters, t = 1.099, which is not statistically significant at 0.01 level of confidence. In the third writing difficulty, Difficulties with writing some high frequency words, t = 0.424, which is not statistically significant at 0.01 level of confidence. In the fourth writing difficulties, Difficulties with discriminating similar sounds, t =0.192, which is not statistically significant at 0.01 level of confidence. In the fifth writing difficulty, Difficulties of misspelling in dictation, t =1.677, which is not statistically significant at 0.01 level of confidence. In the sixth writing difficulties, Difficulties with punctuation and grammar, t =0.719, which is not statistically significant at 0.01 level of confidence.

3.3. Instruments and materials of the study

3.3.1. The reading and writing difficulties checklist

The reading and writing difficulties checklist aimed at identifying the difficulties of 2nd year prep school pupils. The checklist was prepared in the light of directives of the ministry of education (2021/2022), the review of literature and related studies on reading and writing difficulties and the diagnostic test. Also, the viewpoints of senior teachers, supervisors and EFL experts were considered

3.3.1.1. Description of the reading and writing difficulties checklist

The checklist, in its initial form consisted of fourteen reading difficulties and sixteen writing difficulties. These were as follows:

Reading difficulties

1. Substitution of a letter or a word instead of others.
2. Have difficulty with recalling the order of words of relevance (e.g.) alphabet, months and days.
3. Have difficulty with dealing with receptive language.
4. Have difficulty with pronouncing words.
5. Have difficulty with guessing the meaning of words and content.
6. Have difficulty with structuring ideas.
7. Have difficulty with remembering short lists.
8. Omission, insertion phonemes to words he reads.
9. Difficulties reading some polysyllabic words.
10. Influent reading (difficulties in fluency).
11. Skipping words.
12. Inability to recognize simple high frequency words (in, at, was…..).

13. Incorrect rapid reading.
14. Lack of comprehension and understanding.

Writing difficulties

1. Has troubles with shape and size of the letter.
2. Difficulty developing and organizing ideas.
3. Difficulty with writing tasks that require creativity and/ or critical thinking.
4. Has troubles with space between letters.
5. Difficulty explaining/ elaborating an idea.
6. Difficulty with word-finding, sentence completion, and written comprehension.
7. Difficulty with written organization of thought.
8. Has troubles writing some high frequency word.
9. Difficulty with written syntax and written grammar that is not duplicated with oral tasks.
10. Omission, substitution, and insertion of some letters in dictation.
11. Misspelling in dictation.
12. Difficulty spacing thing out on paper or with margins (poor spatial planning).
13. Inconsistency in letter and word spacing.
14. Difficulties in discriminating similar sounds.
15. Poor spelling, including unfinished words, or missing words or letters.
16. Punctuation errors and grammar.

3.3.1.2. Validity of the reading and writing difficulties checklist

A panel of jury members (including faculty members of EFL in faculties of education, some supervisors and senior teachers of EFL at the prep stage) were requested to validate the reading and writing difficulties checklist. The jurors validated it and provided some comments. The researcher modified and refined the checklist accordingly. Some of the comments and remarks raised by the jurors were as follows:

1-For reading difficulties checklist:

1. Modifying the difficulty "His reading was not fluent (difficulties in fluency)" to "Difficulties reading fluency".
2. Omitting the difficulty "Have difficulty with structuring ideas as it is too difficult for the pupils at this stage.

3. Omitting the difficulty " Have difficulty with recalling the order of words of relevance (e.g.) alphabet, months and days as it is not clear.
4. Rearranging the order of skills according to their relative importance.

2-For writing difficulties checklist:

1. Modifying the difficulty "Has troubles with shape and size of the letter" to "Difficulties with shape and size of the letters.
2. Omitting the difficulty "Difficulty developing and organizing ideas" as it is too difficult for the pupils at this stage.
3. Omitting the difficulty "Difficulty with written syntax and written grammar that is not duplicated with oral tasks as it is not clear.
4. Rearranging the order of skills according to their relative importance.

3.3.2. The reading and writing difficulties Pre/ Post- test

In its pre- administration, it aimed at ensuring the equivalence of both the experimental and control groups on reading and writing difficulties in their entry level. Post- testing aimed at measuring 2nd year prep pupils' progress on reading and writing difficulties due to the haptic virtual reality.

To construct the test, the researcher referred to the directives of the Ministry of Education particularly the reading and writing skills of the prep stage and reviewed literature and related studies regarding the reading and writing difficulties. Also, the various reading and writing difficulties tests for beginners and intermediate pupils were previewed. The reading difficulties test consisted of seven questions that were as follows:

1. The first question tested the pupils' difficulties reading some poly syllabic words.
2. The second question tested the pupils' difficulties reading fluency.
3. .The third question tested the pupils' difficulties of recognizing simple high frequency words.
4. The fourth question tested the pupils' difficulties of incorrect rapid reading.
5. The fifth question tested the pupils' difficulties of skipping words.

6. 6.The sixth question tested the pupils' difficulties of substitution of a letter or a word instead of others.
7. The seventh question tested the pupils' difficulties of comprehension and understanding.

The writing difficulties test consisted of sex questions that were as follows:

1. The first question tested the pupils' difficulties of shape and size of the letter.
2. The second question tested the pupils' difficulties of space between letters.
3. The third question tested the pupils' difficulties of writing some high frequency words.
4. .The fourth question tested the pupils' difficulties of discriminating similar sounds.
5. .The fifth question tested the pupils' difficulties of misspelling in dictation.
6. The sixth question tested the pupils' difficulties with punctuation and grammar.

3.3.2.1. Description of the reading and writing difficulties Pre/ Post-test:

The reading pre/ post- difficulties test consisted of seven questions. In the first question, the participants were asked to read five sentences and decide how many syllables are there in each word. In the second question, the participants were instructed to read the passage aloud. In the third question, the participants are asked to read the words and complete the missing letters from the box. The fourth question is a passage which the pupils are informed to read aloud and correctly. In question five, the participants read the passage aloud and asked to put a circle around the words they can't read. Question sex requires the pupils to choose the correct word that complete the sentences. In the last question, the participants were asked to read the passage to choose whether the sentences are true or false. The test required about 45 minutes to complete.

The writing pre/ post- difficulties test consisted of sex questions. In the first question, the participants were asked write some words correctly using the lines given. In the second question, the participants were instructed to write some sentences correctly on lines given. In the third question, the participants are asked to look at the puzzle and find the

pronoun words. The fourth question is a passage which the pupils are informed to look at these words and circle the words begin with (b) letter. In question five, the participants read and correct the underlined words. Question sex requires the pupils to punctuate the following sentences. The test required about 45 minutes to complete.

3.3.2.2. Validity of the test

To determine the reading and writing difficulties test validity, they were submitted to a panel of jurors (N=8), comprising faculty members in EFL, and supervisors of EFL. The jury members gave their opinions and remarks concerning the suitability of items to the stated skills of the test, the adequacy of test items and their appropriateness for the determined skills and the clarity of the test instructions. The researcher made the necessary changes in the light of the jurors' comments and remarks. Some of such suggestions and modifications included:

1. Eliminating the Arabic translation of some items.
2. Rewording some difficult words that might seem too difficult and beyond the pupils' level.
3. Omitting some questions that seemed irrelevant.
4. Assigning three opinions, for MCQs, instead of four options.

After making the suggested modifications, the final version of the reading and writing difficulties test is attached in the appendix (c).

3.3.2.3. Reliability of the Test

In order to calculate the reliability of the test, the test – retest method was used where the test was administered to (20) pupils (not included in the main intervention) from El Waay El Kawmy- prep school, Shebin El Kom, Menofia Governorate. Pearson Correlation (r) was used to calculate the correlation between the two administrations. The reliability of the test in terms of test- retest method can be shown in the following table:

Table (4): The reliability of the reading difficulties test using test- retest method.

Difficulties	N	Cronbach's alpha	Pearson correlation
1-Difficulties reading some poly syllabic words.	20	0.688	0.731
2-Difficulties reading fluency.	20	0.621	0.740
3-Difficulties of recognizing simple high frequency words.	20	0.650	0.743
4- Difficulties of incorrect rapid reading.	20	0.777	0.718
5-Difficulties of skipping words.	20	0.528	0.752
6- Difficulties of substitution of letter or a word instead of others.	20	0.673	0.732
7-Difficulties of comprehension and understanding.	20	0.655	0.712

Results in table (٥) indicated that correlation between the two administrations for the seven difficulties was (0.731, 0.740, 0.743, 0.718, 0.752 and 0.732). Pearson Correlation (r) was statically significant at (0.01) level of confidence. The correlation coefficient was (0.749) which is highly reliable.

Table (5): The reliability of the writing difficulties test using test- retest method.

Difficulties	N	Cronbach's alpha	Pearson correlation
1-Difficulties with shape and size of the letter.	**20**	**0.688**	**0.731**
2-Difficulties space between letters.	**20**	**0.621**	**0.740**
3-Difficulties of writing some high frequency words.	**20**	**0.650**	**0.743**
4- Difficulties of discriminating similar sounds.	**20**	**0.777**	**0.718**
5-Difficulties of misspelling in dictation.	**20**	**0.528**	**0.752**
6- Difficulties with punctuation and grammar.	**20**	**0.673**	**0.732**

Results in table (7) indicated that correlation between the two administrations for the six difficulties was (0.731, 0.740, 0.743, 0.718, 0.752 and 0.732). Pearson Correlation (r) was statically significant at (0.01) level of confidence. The correlation coefficient was (0.749) which is highly reliable.

3.3.2.4. Piloting the reading and writing difficulties test:

The test was piloted by administering it to a group of (20) 2nd year prep school pupils from El Waay El Kawmy prep school, Shebin El Kom, Menofia Governorate. These (20) pupils were not included in the main intervention. Piloting the test aimed at determining the difficulty rate, readability, and test timing. The test time was estimated to be (45) minutes. It was computed by taking the average of time taken by each pupil having the test.

3.5. Haptic virtual reality program

3.5.1. Aims and objectives of the Program:

The current program aimed to help 2nd year prep. school pupils remedy their reading difficulties and writing difficulties using haptic virtual reality. By the end of using the manual, the pupils should be able to:

1- Recognize simple high frequency words (in, at, was…..).
2- Read fluently without difficulties.
3- Read some poly syllabic words without difficulties.
4- Read rapidly and correctly.
5- Recognize the definition of reading difficulties.
6- Recognize the definition of writing difficulties.
7- Recognize the definition of haptic virtual reality.
8- Identify the reason of learning haptic virtual reality and its relation with reading difficulties and writing difficulties.
9- Recognize how to use haptic virtual reality to help those with reading difficulties and writing difficulties.
10- Write some high frequency word without troubles.
11- discriminate similar sounds.

3.5.2. Constructing the Program:

Based on reviewing literature and related studies, the aims of TEFL in the prep stage in Egypt (directives of the Ministry of Education) and surveying various theses and dissertations conducted on reading and writing difficulties, the researcher prepared the manual. It helps to encourage and

motivate the effective participation by learners. The researcher made use of the literature and previous studies such as (Barnett, 2020); (Akramovna, 2020); (Chung, 2020); (Ismiati, 2021); (Nobel, 2021); (Ghulamuddin, 2021).

3.5.3. The content of the Program:

The experiment is composed of thirteen sessions; one pre-test session, one post- test session and one orientation session in which are introduced to the program aim and objectives, the procedures to be followed in the following sessions, the skills to be dealt with later on and the haptic virtual reality and how to use it. The other eleven sessions were the core of the content. The researcher selected units from students' book. The sessions were divided into reading sessions and writing sessions.

3.6. Evaluation of the Program:

The researcher used both forms of assessment; namely formative assessment during the sessions and summative assessment at the end of intervention.

4. Findings and discussion

Hypothesis One:

"There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in the overall reading skills post- test in favor of the experimental group."

To verify the differences of the two groups, the results of the post- test were subjected to statistical. The t-test for independent samples was used to find if there was a statistically significant difference between them. This can be shown in table (6):

Table (6): Means, standard deviation and mean difference of the control and the experimental group in overall reading skills.

Skill	Group	N	Mean	S. D	Minimum	Maximum	total score	Mean difference
Reading difficulties	Experimental	34	28.052	3.162	12	34	35	10.334
	Control	34	17.708	2.917	9	27		

Results in table (10) revealed that the control group pupils' mean scores in overall reading skills on the post- reading difficulties test was (17.708). On the other hand, the experimental group pupils' mean scores in overall reading skills on the post- reading test was (28.052). These results indicate that the higher mean is for the experimental group's post

administration of the reading test. Thus, it could be said that pupils' overall reading difficulties improved after teaching using haptic virtual reality. Such improvement may be due to using haptic virtual reality technology. This can be shown graphically in the following figure:

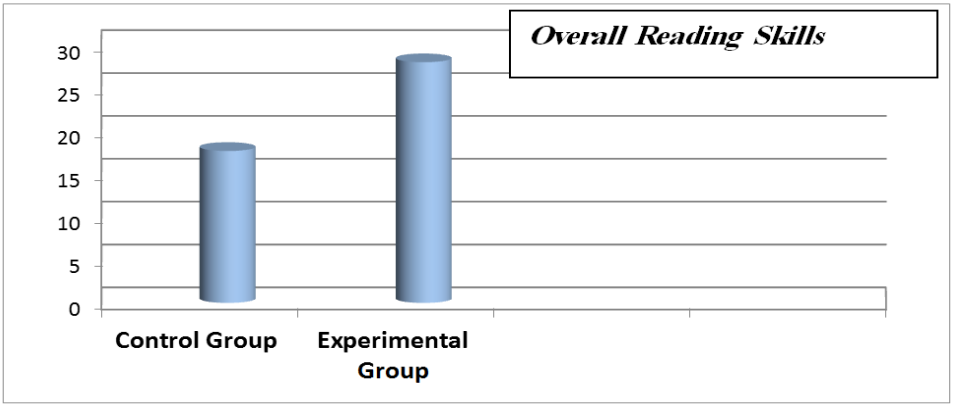

Figure (1): Bar Charts of the Mean Scores of the Control Group and the Experimental Group of Overall Reading skills Post – Test.

In order to investigate the effect size and educational importance of the results and its educational importance and effectiveness; the value of ETA square (η^2) was calculated as its value (ETA square) was (0.74). ETA square value which was significant to the high effect and educational importance and the practical significance exceeded the results in the psychological studies which were 0.14. In the light of this, it can be said that 74% of the variations between the scores of students in the reading difficulties could be due to the experimental procedures. There was high educational importance for using haptic virtual reality technology to remedy reading difficulties. This is shown in the following table:

Table (7): Eta square (η^2) of the statistical difference between the Mean scores of both groups in the reading difficulties post- test.

Skill	Group	N	Mean	S.D	T-value	D.F	Sig	η^2	Effectiveness
Reading skills	Experimental	34	28.052	3.162	13.812	66	Significant at (0.01)	0.74	Significant & educationally important
	Control	34	17.708	2.917	13.812				

4.1.2. Verifying the second hypothesis of the study:

Hypothesis two:

"There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in each of the reading skills post- test in favor of the experimental group."

To verify the differences of the two groups, the results of the post- test were subjected to statistical treatment. The t-test for independent samples was used to find if there was a statistically significant difference between them. This can be shown in table (8):

Table (8): Means, standard deviation and mean difference of the control and the experimental group in each of reading skills

Subskill	Group	N	Mean	S. D	Minimum	Maximum	Mean difference
Difficulties reading some poly syllabic words	Experimental	34	4.316	1.421	3	5	1.23
	Control	34	2.575	1.395	1	5	
Difficulties of incorrect rapid reading.	Experimental	34	4.127	1.404	2	5	1.68
	Control	34	2.691	1.431	1	4	
Difficulties of skipping words.	Experimental	34	4.119	1.322	2	5	1.54
	Control	34	2.577	1.256	1	4	
Difficulties of substitution of a letter or a word instead of others.	Experimental	34	3.851	1.214	2	5	1.41
	Control	34	2.437	1.322	0	4	
Difficulties of comprehensio n and understanding	Experimental	34	3.851	1.214	2	5	1.42
	Control	34	2.437	1.322	1	4	
Difficulties reading fluency	Experimental	34	4.127	1.404	2	5	1.68
	Control	34	2.691	1.431	1	4	
Difficulties of recognizing simple high frequency words	Experimental	34	4.119	1.322	2	5	1.54
	Control	34	2.577	1.256	1	4	

Results in table (8) revealed that the control group pupils' mean scores in each reading difficulties on the post- reading difficulties test was (2.575), (2.691), (2.577), (2.437), (2.437), (2.691) and (2.577). On the other hand, the experimental group pupils' mean scores in each reading difficulties on the post- reading difficulties test was (4.316), (4.127), (4.119), (3.851), (3.851), (4.127) and (4.119). These results indicate that the higher mean is for the experimental group's post administration of the reading difficulties test. Thus, it could be said that pupils' each reading difficulties improved after teaching using haptic virtual reality. Such improvement is due to using haptic virtual reality technology. This can be shown graphically in the following figure:

Figure (2): Bar Charts of the Mean Scores of the Control Group and the Experimental Group of Each Reading Difficulties Post – test

In order to investigate the effect size and educational importance of the results and its educational importance and effectiveness; the value of ETA square (η^2) was calculated as its value (ETA square) was (0.28), (0.25), (0.23), (0.24), (0.27), (0.20) and (0.26). ETA square value which was significant to the high effect and educational importance and the practical significance exceeded the results in the psychological studies which were 0.14. In the light of this, it can be said that 28%, 25%, 23%, 24%, 27%, 20%

and 26% of the variations between the scores of students in each of the reading difficulties could be due to the experimental procedures. There was high educational importance for using haptic virtual reality technology to remedy reading difficulties. This is shown in the following table:

Table (7): Eta Square (ɳ2) of the statistical difference between the mean scores of both groups in each of the reading difficulties.

Subskill	Group	N	Mean	S. D	T-value	D.F	Sig	ɳ2	Effectivene
Difficulties reading some poly syllabic words	Experimental	**34**	**4.316**	**1.421**	**5.022**	**66**	Significant at (0.01)	**0.28**	Significant & educationally important
	Control	**34**	**2.575**	**1.395**					
Difficulties of incorrect rapid reading.	Experimental	**34**	**3.971**	**1.319**	**4.711**	**66**	Significant at (0.01)	**0.25**	Significant & educationally important
	Control	**34**	**2.463**	**1.281**					
Difficulties of skipping words.	Experimental	**34**	**3.885**	**1.207**	**4.396**	**66**	Significant at (0.01)	**0.23**	Significant & educationally important
	Control	**34**	**2.601**	**1.165**					
Difficulties of substitution of a letter or a word instead of others.	Experimental	**34**	**3.851**	**1.214**	**4.525**	**66**	Significant at (0.01)	**0.24**	Significant & educationally important
	Control	**34**	**2.437**	**1.322**					
Difficulties of comprehension and understanding	Experimental	**34**	**3.851**	**1.214**	**4.525**	**66**	Significant at (0.01)	**0.27**	Significant & educationally important
	Control	**34**	**2.437**	**1.322**					
Difficulties reading fluency	Experimental	**34**	**4.127**	**1.404**	**4.115**	**66**	Significant at (0.01)	**0.20**	Significant & educationally important
	Control	**34**	**2.691**	**1.431**					
Difficulties of recognizing simple high frequency words	Experimental	**34**	**4.119**	**1.322**	**4.857**	**66**	Significant at (0.01)	**0.26**	Significant & educationally important
	Control	**34**	**2.577**	**1.256**					

4.1.2. Verifying the third hypothesis of the study:

Hypothesis three:

"There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in the overall writing skills post- test in favor of the experimental group."

To verify the differences of the two groups, the results of the post- test were subjected to statistical. The t-test for independent samples was used to find if there was a statistically significant difference between them. This can be shown in table (9):

Table (9): Means, standard deviation and mean difference of the control and the experimental group in overall writing skills.

Skill	Group	N	Mean	S. D	Minimum	Maximum	total score	Mean difference
writing skills	Experimental	34	24.873	2.971	13	32	35	8.842
	Control	34	16.031	2.768	9	27		

Results in table (9) revealed that the control group pupils' mean scores in overall writing difficulties on the post- writing difficulties test was (16.031). On the other hand, the experimental group pupils' mean scores in overall writing on the post- writing difficulties test was (24.873). These results indicate that the higher mean is for the experimental group's post administration of the writing difficulties test. Thus, it could be said that pupils' overall writing difficulties improved after teaching using haptic virtual reality. Such improvement may be due to using haptic virtual reality technology. This can be shown graphically in the following figure:

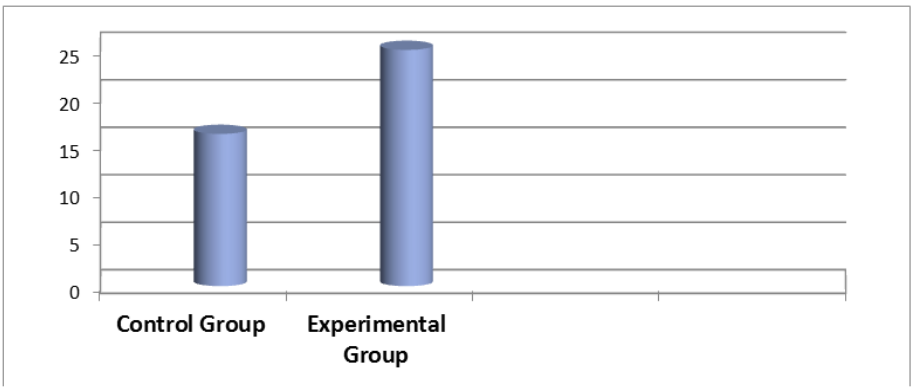

Figure (3): Bar Charts of the Mean Scores of the Control Group and the Experimental Group on Overall Writing Difficulties post – test.

In order to investigate the effect size and educational importance of the results and its educational importance and effectiveness; the value of ETA square (η^2) was calculated as its value (ETA square) was (0.70). ETA square value which was significant to the high effect and educational importance and the practical significance exceeded the results in the psychological studies which were 0.14. In the light of this, it can be said that 70% of the variations between the scores of students in the reading difficulties could be due to the experimental procedures. There was high educational importance for using haptic virtual reality technology to remedy reading difficulties. This is shown in the following table:

Table (10): Eta square (η^2) of the statistical difference between the Mean scores of both groups in the writing difficulties post- test.

Skill	Group	N	Mean	S. D	T-value	D.F	Sig	η^2	Effectiveness
writing skills	Experimental	34	24.873	2.971	12.508	66	(0.01)	0.70	Significant & educationally important
	Control	34	16.031	2.768					

4.1.2. Verifying the fourth hypothesis of the study:

Hypothesis four:

"There would be a statistically significant difference at (0.01) level between the experimental and the control groups' mean scores in each of the writing skills post- test in favor of the experimental group.".

To verify the differences of the two groups, the results of the post-test were subjected to statistical treatment. The t-test for independent samples was used to find if there was a statistically significant difference between them. This can be shown in table (11):

Table (11): Means, standard deviation and mean difference of the control and the experimental group in each of writing difficulties

Subskill	Group	N	Mean	S. D	Minimum	Maximum	Mean difference
Difficulties with Shape and Size of the letter	Experimental	34	4.491	1.384	2	5	1.688
	Control	34	2.608	1.405	1	4	
Difficulties with space between letters	Experimental	34	4.491	1.384	2	5	1.883
	Control	34	2.608	1.405	1	4	
Difficulties of writing some high frequency words.	Experimental	34	4.253	1.531	2	5	1.739
	Control	34	2.614	1.399	1	4	
Difficulties with discriminating similar sounds.	Experimental	34	4.171	1.437	3	5	1.44
	Control	34	2.890	1.512	1	5	
Difficulties of spelling in dictation.	Experimental	34	3.936	1.377	2	5	1.325
	Control	34	2.611	1.265	1	4	
Difficulties with punctuations and grammar	Experimental	34	3.519	1.315	2	4	1.026
	Control	34	2.493	1.450	1	3	

Results in table (11) revealed that the control group pupils' mean scores in each writing difficulties on the post- writing difficulties test was (2.608), (2.608), (2.614), (2.890), (2.611) and (2.493). On the other hand, the experimental group pupils' mean scores in each writing difficulties on the post- writing difficulties test was (4.491), (4.491), (4.253), (3.171), (3.936) and (4.519). These results indicate that the higher mean is for the experimental group's post administration of the writing difficulties test. Thus, it could be said that pupils' each writing difficulties improved after teaching using haptic virtual reality. Such improvement is due to using

haptic virtual reality technology. This can be shown graphically in the following figure:

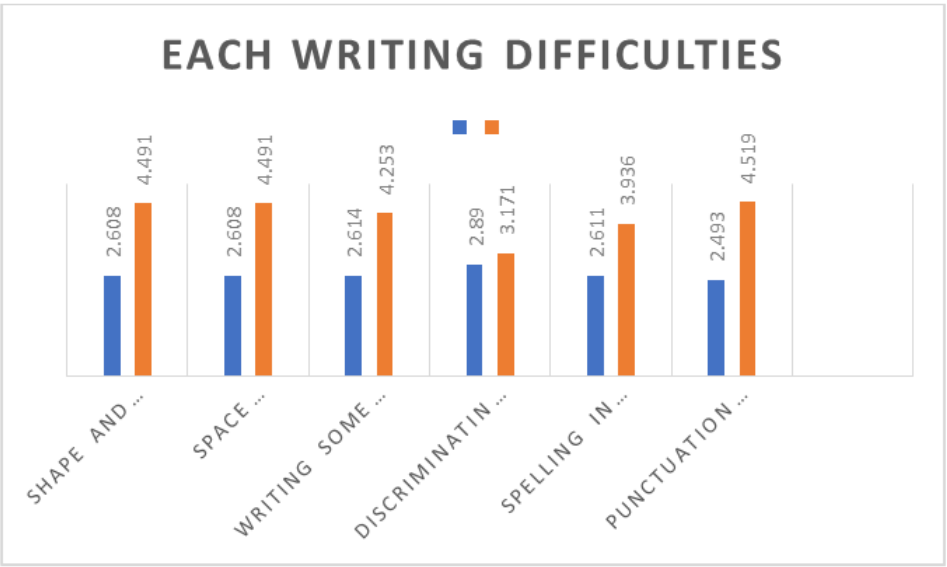

Figure (4): Bar Charts of the Mean Scores of the Control Group and the Experimental Group of Each Writing Difficulties Post – test

In order to investigate the effect size and educational importance of the results and its educational importance and effectiveness; the value of ETA square (η^2) was calculated as its value (ETA square) was (0.31), (0.31), (0.24), (0.24), (0.16), (0.20) and (0.12). ETA square value which was significant to the high effect and educational importance and the practical significance exceeded the results in the psychological studies which were 0.14. In the light of this, it can be said that 31%, 31%, 24%, 24%, 16%, 20% and 12% of the variations between the scores of students in each of the reading difficulties could be due to the experimental procedures. There was high educational importance for using haptic virtual reality technology to remedy writing difficulties. This is shown in the following table:

Table (12): Eta Square (η2) of the statistical difference between the mean scores of both groups in each of the writing difficulties.

Subskill	Group	N	Mean	S. D	T-value	D.F	Sig	η2	Effectiveness
Difficulties with Shape and Size of the letter	Experimental	34	4.491	1.384	5.485	66	(0.01)	0.31	Significant & educationally important
	Control	34	2.608	1.405					
Difficulties with space between letters	Experimental	34	4.491	1.384	5.485	66	(0.01)	0.31	Significant & educationally important
	Control	34	2.608	1.405					
Difficulties of writing some high frequency words.	Experimental	34	4.253	1.531	4.539	66	(0.01)	0.24	Significant & educationally important
	Control	34	2.614	1.399					
Difficulties with discriminating similar sounds.	Experimental	34	4.171	1.437	3.527	66	(0.01)	0.16	Significant & educationally important
	Control	34	2.890	1.512					
Difficulties of spelling in dictation.	Experimental	34	3.936	1.377	4.070	66	(0.01)	0.20	Significant & educationally important
	Control	34	2.611	1.265					
Difficulties with punctuations and grammar	Experimental	34	3.519	1.315	3.011	66	(0.01)	0.12	Significant & educationally important
	Control	34	2.493	1.450					

4.6. Discussion of the results

The results of the experimental and control groups on the reading difficulties and writing difficulties pre- test indicated that both groups were approximately equal in their entry level on their reading difficulties and writing difficulties before teaching using the teacher's guide of haptic virtual reality technology. In addition, the results of both groups on the reading

difficulties and writing difficulties pre- test showed pupils' poor level in the determined reading difficulties and writing difficulties. Having taught using the haptic virtual reality technology, post- testing results revealed significant differences between the experimental group pupils who were taught via haptic virtual reality technology while the control group pupils received regular instruction. This finding indicated that haptic virtual reality technology proved to be effective to remedy the experimental group pupils' reading difficulties and writing difficulties. The effect size was also calculated to identify the level of effectiveness which completes the statistical significance. Eta square (ɳ2) values of overall reading difficulties and writing difficulties and each of the reading difficulties and writing difficulties of the post- test were high.

Also, the results of the post test revealed that the level of the experimental group pupils was higher than that of the control group due to the haptic virtual reality technology. The results are consistent with Ahmet (2020) which aims to fill in this gap by investigating the effect of virtual reality enhanced learning environment on the 7th-grade students' academic achievements on reading and writing in English, and revealed that immersive VR outperformed all other classical materials, especially textbooks, by providing students with sensory information in three dimensions.

It also pointed out that immersive VR involves students as first-person in their classroom activities, creating positive changes in their reading and writing skills. In this respect, it is recommended that English learning environments, which aim to improve students' reading and writing skills, include immersive VR systems.

The results revealed that reading and writing texts with the accompaniment of haptic virtual reality technology enabled pupils to comprehend easier and more concentrate than traditional education. The haptic virtual reality provided students with sensory information in three dimensions. It also pointed out that immersive VR involves students as first-person in their classroom activities, creating positive changes in their reading and writing skills. These results are in line with Ahmet (2020) 's results.

Moreover, the current study findings are consistent with Rodríguez-Cano (2021) concluded that virtual reality technology is an interesting

avenue of treatment, as it offers a ludic, safe, controlled, and motivating environment for students with dyslexia. He added that through technology and specifically through virtual reality, enabling an immersive and attractive environment to develop the skills of students with dyslexia, becoming the first virtual reality game with an inclusive approach whose development has been carried out based on the contributions of users as well as by collecting the most used lines of intervention in the intervention process of children with this learning difficulty. However, from the work team, we believe it is necessary to continue advancing in this field in order to give scientific support to the use of virtual reality in the diagnosis and treatment of dyslexia.

That is to say it can develop their reading difficulties and writing difficulties and this what is the current study aimed to investigate. In other words, haptic virtual reality technology proved to be effective to remedy reading and writing difficulties.

5.2. Conclusions:

Within the delimitations of the study and on the basis of the study results, the following conclusions have been drawn:

1. Haptic virtual reality technology is effective to remedy pupils' reading difficulties and writing difficulties.
2. Haptic virtual reality may provide a means to foster the process of learning among students. It employs an important role in teaching reading and writing to EFL learners who faces difficulties.
3. Haptic virtual reality has significance in shaping the cognitive structure and generating meaningful learning. This technology is usable for every branch of education.
4. The technology of haptic virtual reality increases the student success and remembrance by the help of its properties such as achieving attention and concretization of information with aid, and having more enjoyable course.
5. The haptic virtual reality appears to enhance the learners' confidence in learning English, no matter in what aspect.
6. Haptic virtual reality represents a visual representation of the learners' cognitive structure, and therefore, can reveal the myth in the learner's mind.

7. Through haptic virtual reality learners become meta-cognitively, motivationally and behaviorally active participants in their learning process.
8. The low performance of the participants of both the control and experimental groups on the pre- test indicates that the current reading and writing difficulties activities for the second-year preparatory pupils do not help pupils remedy their reading difficulties and writing difficulties.
9. Integrating technology into the content areas can be useful and helpful to enhance reading and writing difficulties.
10. Through multimedia and haptic virtual reality pupils have the opportunities to have active reading and writing and become good readers and writers.
11. Virtual Reality-Based English teaching had positive effects on the students' academic achievement. The students' cognitive skills improved especially at high levels. In the virtual reality environment, students were responsible for their own English learning. The English texts that appear on the virtual reality screens especially during their activities in an environment close to the real images contributed to the students' improvement of reading and writing skills.

In conclusion, most of the virtual reality studies in English teaching focus on non-immersive virtual reality (desktop virtual reality) employing graphics workstation using a monitor, a keyboard, and a mouse. One study which uses immersive virtual reality in language teaching is presented by Cheng, Yang and Andersen (2017), which employs an immersive virtual reality technology (Oculus Rift) to teach embodied cultural interaction, such as bowing in Japanese greetings. This study, which aims to fill in this gap by investigating the use of haptic virtual reality to remedy EFL reading difficulties and writing difficulties among second year preparatory pupils, reveals that immersive virtual reality outperformed all other classical materials, especially textbooks, by providing students with sensory information in three dimensions. It also points out that immersive virtual reality involves students as first-person in their classroom activities, creating positive changes in their reading and writing skills.

During next decade, virtual technologies will revolutionize the way people interact in a similar way Internet and smartphones did. Low-cost headsets will be an additional, accessible, powerful, and affordable complement to mobile devices. As a consequence, it will be possible to conduct immersive experiences by interacting with objects, concepts, or processes, as a regular learning workflow in any educational level, from primary school to higher education.

5.3. Recommendations:

Based upon the findings of the study and the above-mentioned conclusions, the following recommendations are suggested:

1. Since reading difficulties and writing difficulties are important, they should receive the attention they deserve. So, more focus should be given to reading and writing difficulties especially in primary and preparatory stages.
2. Teachers should be aware of the importance of reading difficulties and writing difficulties and how to help their pupils overcome their reading and writing difficulties.
3. More activities based on multimedia, computers and internet should be integrated in teaching EFL.
4. Group work and pair work should be encouraged during the process of teaching reading and writing.
5. Pupils/ students - centered learning should be emphasized and activities (before, during and after reading/ writing) should be maximized.
6. Cooperative learning can be highlighted through sharing and group work activities.
7. English language teachers should be trained to use such haptic virtual reality technology that helps maximize teaching and learning.
8. Immediate feedback should be given after each activity to enhance their pupils'/ students' learning.
9. Reading and writing difficulties should be evaluated during the whole year regularly to help pupils be accustomed to such a skill and overcome their fear and problems.

10. More haptic virtual reality strategies and activities should be used during the process of learning in general and in teaching English in particular.
11. A good training should be given to the teachers and pupils to use haptic virtual reality in class.

In this respect, it is recommended that English learning environments, which aim to improve students' reading and writing skills, include immersive VR systems.

4.7. Suggestions of further research:

The current study attempted to investigate the use of haptic virtual reality to remedy EFL reading difficulties and writing difficulties among preparatory school pupils. There are other areas that can be explored:

1. Using haptic virtual reality technology in developing listening skill.
2. Using haptic virtual reality technology in developing oral communication skills (speaking and listening).
3. The impact of haptic virtual reality technology on the pupils' thinking skills.
4. The effect of haptic virtual reality technology in developing primary and/ or secondary school pupils.
5. Using haptic virtual reality technology in developing speaking skill.

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