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Exploring the Viability of Augmented Reality-based Cognitive Therapy of Poor Working Memory in Lifelong English for Medical Purposes (EMP) Comprehension: A Complementarity Study

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Original Article

Abstract

Introduction: The aim of this study is to determine the effectiveness of cognitive therapy of poor working memory (WM) in students through self-generated augmented-reality (AR) based flipped English for Medical Purposes (EMP) reading classes on quality of students' academic and professional lives.

Materials and Methods: This complementarity study was conducted using the semi-experimental method with a cross-contextual (continuous and real-workplace) assessment design along with soliciting attitudes and debriefing perception in the very initial and final phases, respectively. In the academic year 2018, after determining the WM capacities of 210 students of medicine from Medical University of Isfahan, Isfahan, Iran, they were randomly divided into seven heterogeneous groups with high visual and/or high verbal WM heads to practice EMP reading comprehension in 18 self-generated AR-based sessions; in each session, they were simultaneously assessed in both instructional-learning context and field.

Results: Student active engagement in self-generating AR-based sessions spread the intrinsic cognitive load of EMP reading materials for students with low WM capacity, suggesting that students are inclined to active-participation courses.

Conclusion: Student active participation in self-generating AR-based activities played a crucial role in cognitive therapy of students' psychological reading process and promoting EMP reading comprehension. However, the results should be viewed as suggestive.

Keywords: Augmented reality; Cognitive therapy; English for medical purposes comprehension; Performance; Working memory

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Introduction

Today, students have more communication with the real world than ever before, and their readiness for future teaching-learning and career areas is a key factor. According to Ascione, "education authorities face many challenges in the present age, the most important of which are active teaching methods and support for learners with poor levels of knowledge" (1). Although language for specific purposes (LSP) courses are offered to some extent in all higher education institutions, learners do not have acceptable performance outcomes in the professional field (2). When it comes to medical education and learning, many English for medical purposes (EMP) programs have failed to keep pace with the dynamism and diversity of learning styles and community health needs (3). EMP is an example of the application of medical science in practice and in real fields (4,5). Meanwhile, the application of cross-contextual learning from the classroom to the field and the

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implementation of real dimensions of life areas have been able to greatly reduce the problems of teaching and learning in this area (6).

Reading comprehension skills and working memory (WM): Reading problems are one of the most controversial issues in the field of language teaching. The presence of learners with different styles in similar teaching-learning contexts has created major problems in student learning and comprehension (7). Paying full attention to textbooks has prevented the activation of pervasive individual abilities (8). There is such an approach in LSP and EMP training, but reading skills are actually used in reading comprehension (9). Deficiencies in cognitive capacities of learners lead to an inappropriate reading comprehension (10).

There are various definitions of WM and its capacity. In the present study, WM was defined as a cognitive system for accessing the information required while reading and understanding content. Similarly, the WM capacity is seen as a visual and verbal construct that varies from person to person (11). The success of reading comprehension depends on cognitive characteristics and the focus on the psychological process of reading has a special place in the field of LSP education (11). Current evidence in the field of LSP reading comprehension explicitly points to the interrelationship between WM and reading comprehension skills; in such a way that the two reinforce each other (10,11). Based on the results of previous studies, WM, which consists of two main parts, visual and verbal, is perhaps one of the most important structures in reading comprehension psychology (12,13). It is clear that learners have different WM capacities. Visual and verbal WM should be considered to predict individual differences in both children and adults (14). Accordingly, reading comprehension can be explained by the processing and storage capabilities of WM of individuals. Deficiency in WM leads to problems in interpreting reading texts, which in turn has an adverse effect on the learning and understanding capabilities of learners, but language education with the help of new educational media cannot be limited to text or images, rather, it is necessary to use both simultaneously (15).

Game-based language teaching and learning in academic education: The advent of simulation has affected areas such as higher education and health; in a way, game-based learning is dynamic today (16). Game-based teaching and learning is employed to create a balance in the field of education and empowerment of learners to learn and apply the subject in real-world scenes, which helps cross-contextual practices from the classroom to real-world professional areas (17).

The new generation of games has launched a huge movement in the field of education and research, in which game-based education has brought about a variety of cognitive-behavioral, affective, and motivational outcomes (18). The new generation of games has developed complex experiences that reflect the principles provided by psychologists, neuroscientists, and educators to make fundamental changes in behavior, facilitate learning, and improve brain function (19). In addition, these games are an up-to-date source of improvement for LSP, providing beneficiaries with a variety of content and activities in the form of video, audio, and text (20). The new generation games have found a variety of applications in promoting the learning of LSP skills. For example, by practicing the augmented reality (AR)-based reading skills in a real-world teaching-learning environment, the learners' ability can be enhanced to use real-time reading content when needed (21). Using AR to teach reading skills for reading ESP, while changing the attitude of learners towards the application of games in ESP education and upgrading the deep understanding of the learners, leads to their better performance in real arenas (22).

In fact, the active contribution of learners in a game-based teaching-learning context brings them self-motivation and self-direction. In a study, learners practiced the principles learned in the general psychology reading course by choosing play-based activities (23). In such an exercise context, there were numerous opportunities for interaction to complete the activities. In this way, learners deepened their knowledge by creating a relationship between their experiences and the game environment.

Although AR-based learning provides the conditions for the formation of good learning habits (21-23), less attention has been paid to its application in LSP skills training so that comprehension skills can be properly applied in real areas to meet the community requirements. In particular, premade games, in which there is no active presence of learners, are not a good option for academic language learning (24). Thus, identifying reading comprehension problems makes it possible to provide various teachings by adapting teaching and learning (25); Because by creating suitable conditions, it is possible to strengthen working memory (14,24,25).

AR-based cognitive therapy and reading comprehension: Cognitive therapy in the field of education identifies the disruptive factors in the psychological process of learning and treatment simultaneously (26-28). Specifically, in language learning, cognitive therapy helps learners to improve their learning and psychological comprehension process

(26). Many limitations in cognitive assessment have led to less investigations in this area. Therefore, attention to the treatment of learners' cognitive disability in higher education has been marginalized (27). AR as a new generation of games adds virtual dimensions to real-world scenes to facilitate understanding of many new aspects (28). In general, more information is needed on the cognitive effect of AR-based activity and the learning psychology process on the needs of ESP comprehension. Balancing problems and solutions in AR-based scenes can increase inclusive motivation of the learner and keep him in the learning process, which is fulfilled by giving the learner an active role while practicing reading content (19).

In order to involve learners in producing educational activities in such a way that they can practice reading content through their self-generated activities, it is necessary to pay attention to the psychological process of reading comprehension (29). This study is performed with the aim to identify the unhelpful patterns and change them for effective functioning in understanding the EMP content through cognitive therapy to investigate the applicability of self-generated AR in the process of English reading comprehension. There is a close relationship between reading skills and WM (26-28). Therefore, it is necessary to examine this relationship in reading ESP when learners play an active role in practicing content. The present study investigates the possible effect of visual and verbal signs of AR-based reading activities on comprehension to provide a basis for cognitive therapy of comprehension of learners with WM impairment. The main assumption was that the psychological processes of ESP reading play an important role in scientific progress and professional performance. Thus, the main goal focused on the extent to which practicing EMP reading content using self-generated AR-based activities strengthens WM and process of comprehension in learners.

Materials and Methods

This study was conducted in the first and second semesters of the 2018-2019 academic year at Isfahan University of Medical Sciences, Isfahan, Iran after being approved with the ethics code IR.MUI.REC.1399.028 by the research ethics committee of this university; the design of this study was approved and registered in the Iranian Registry of Clinical Trials (IRCT) system, which according to the announcement of this system was not eligible to obtain the code.

An experimental design was used to perform this complementarity study; In this way, in addition to measuring the working memory of the participants, they first expressed their attitude towards learning English reading with the help of games. The progress of their perception and performance was assessed in a formative way. Finally, in an interview, the participants expressed their perceptions of AR-based English reading education.

The target population included students studying at Isfahan University of Medical Sciences who had adopted EMP course as two compulsory credits in the first semester of the academic year. The participants' consent was obtained at the beginning of the semester to participate in the study. Reluctance to participate in the AR-based self-generated activity training courses and absence of more than three sessions in the course were considered as the exclusion criteria.

The following steps were taken to integrate cognitive therapy and AR in teaching EMP comprehension.

Step 1: Attitude assessment

By conducting a pilot study, the study objectives were explained to the participants. In this step, the data collection process began with the distribution of a researcher-made questionnaire in the first language of the participants (Persian, Arabic, and Turkish). The questionnaire sought the learners' attitude toward the use of educational technology in teaching and learning English (Table 1).

By responding to the items, the participants expressed their approach to role-playing in designing and practicing the game-based activities. The questionnaire was based on a five-point Likert scale. The responses were analyzed descriptively by calculating the relative frequency. At the end of this step, the participants took the English Reading Sufficiency Test, which included 40 selected questions from the language tests of the Iranian Ministry of Health and Medical Education.

The strongly disagree and strongly agree options indicated the lowest and the highest desire or benefit, respectively.

Step 2: Assessment of WM, education and evaluation

To answer the study question, at the earliest point of this step, the visual and verbal WM assessment test with 40 questions was held for 5 minutes. The assessment process was designed based on the framework presented by Chen et al. (10) and the visual capacity assessment proposed by Tanabe and Osaka (30). In this way, an image appeared on the mobile phone of the participants for three seconds and then they had two seconds to answer the question about the image. For example, a three-part image with an airport view with an enclosed section was displayed on the participants' mobile phones for three seconds and they had two seconds to answer the question (Figure 1).

Table 1. Researcher-made questionnaire to assess participants' attitudes about the use of educational technologies in English teaching-learning

Items	Strongly disagree	Disagree	No comment	Agree	Strongly agree
I am interested in using training and interaction technology.					
I want to learn English reading skills using technology.					
Combining technology with traditional teaching methods in learning English reading.					
I want to learn English using new technologies.					
Learning English in a real environment is useful.					
I want to practice English reading in the educational environment and work environment.					
I want to learn English with the help of games.					
Education through games creates a connection between the educational environment and the work environment.					
I want to practice EMP reading skills by playing.					
Practicing English using games enhances the ability to transfer to the arena.					
The text in the game helps learning ESP.					
I am interested in playing an active role in the production of game-based activities.					
Game-based education addresses different needs in society.					
Sharing ideas in English reading practice can be performed easily using games.					

EMP: English for medical purposes; ESP: English for special purposes

Figure 1. A view of the visual working memory (WM) test question

To measure verbal WM, a sentence was displayed to the participants for three seconds and then they were asked a question about the sentence and they had two seconds to answer (Figure 2).

Figure 2. A view of the verbal working memory (WM) test question

Since there was no specific cut-off point for determining the strength or weakness of the learners' visual and verbal WM, the score of each of them was converted to the standard scores. In other words, each participant was assigned a score with a mean of zero and a standard deviation (SD) of one. Thus, learners were placed in a quartile. Figure 3 demonstrates the WM measurement process.

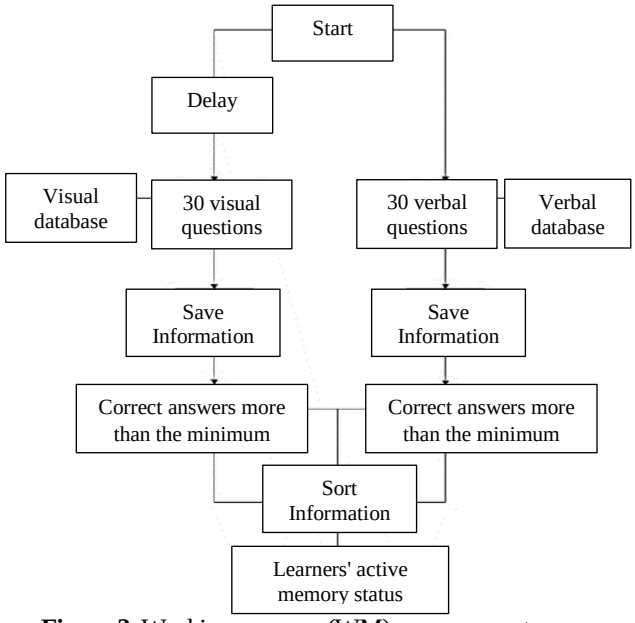

Figure 3. Working memory (WM) measurement process

Table 2. View of the groups and demographic characteristics of the members of each group

Group	Characteristics			Age (year) (mean ± SD)	Gender [n (%)]	
	Leader	Visual memory	Verbal memory		Male	Female
1	Visual*	-	-	20.30 ± 0.90	8 (26.7)	22 (77.3)
2	Verbal**/Visual*	-	-	21.04 ± 0.40	9 (30.0)	21 (70.0)
3	Visual*	-	+	19.90 ± 0.10	7 (33.3)	23 (76.7)
4	Verbal**	+	-	20.70 ± 1.03	5 (16.7)	25 (83.3)
5	Verbal**/Visual*	+	-	21.00 ± 0.80	8 (26.7)	22 (77.3)
6	Verbal**	-	-	21.70 ± 0.30	6 (20.0)	24 (80.0)
7	Verbal**/Visual*	+	+	21.90 ±1.10	7 (33.3)	23 (76.7)

Visual*: A learner with a strong visual working memory (WM); Verbal**: A learner with a strong visual working memory (WM); SD: Standard deviation

Each participant was defined with a strong or weak visual and verbal WM. Then they were divided into 7 groups with 5-person circles (Table 2) so that each group included 30 members and 6 circles of five. These interdisciplinary and heterogeneous circles consisted of learners with different levels of English reading. Each circle had a leader with strong visual or verbal WM. There was no significant difference between the attitudes of the group participants.

The reading content was selected from textbooks approved by the istry of Health and Medical Education (31-35). Accordingly, 18 training and assessment sessions were conducted. These sessions were of the flipped classroom type, during which instructors of specialized fields or English in online classes taught EMP reading content outside the classroom. Accordingly, the context of the class was devoted to practicing the AR-based content. At the beginning of each session, the participants created AR-based activities to practice in subsequent sessions in collaboration with each other and in groups of five. Figure 4 illustrates a view of scenes of the AR-based self-generated activities (in which the user is sitting behind a personal computer and is not actually moving).

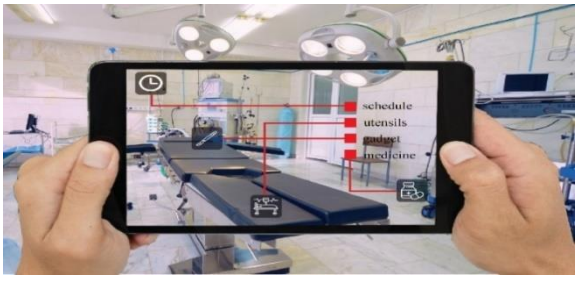

Figure 4. A view of scenes of augmented reality (AR)-based self-generated activity

The participants were continuously assessed through the activities of the EMP books in 16 sessions (except the first and second sessions) in the final minutes of each online class. In fact, the activities of the books became evaluable. These activities were of reading comprehension type and included questions in the True/False/Not mentioned, multiple choice, rewind, and closure frameworks. Therefore, a score was recorded for each participant in each session.

Step 3: Assessment in the field

Finally, the performance of the participants in the field during the training period up to the following six months was evaluated using a short clinical test (36). For this purpose, each participant was exposed to a patient during the course. Proper interaction, diagnosis, and treatment were the main criteria for measuring his performance. The descriptive and inferential analysis of data obtained from the learners' performance in the field was performed through the repeated measures analysis of variance (ANOVA) test.

Step 4: Concentrated interview

In the last step, from the seven study groups, 2 participants with the lowest and highest reading comprehension scores were selected to answer the three interview questions including "Which characteristics were effective in EMP reading? What characteristics facilitated your reading comprehension course? and what characteristics of this period do you think strengthened your progress and performance?"

The answers of each participant to the interview questions were recorded and transcribed by the researchers. The participants' responses were analyzed using a theme-based analysis. For this purpose, all responses were coded in main and sub categories. An overview of the study process is shown in figure 5.

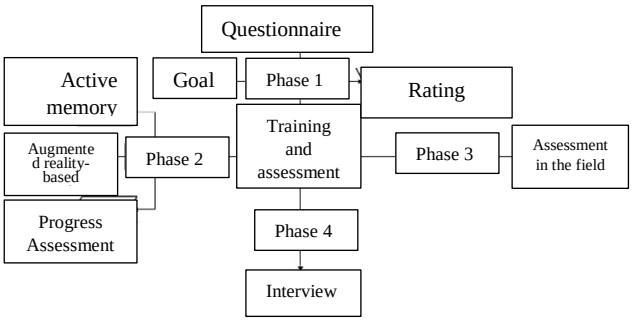

Figure 5. An overview of the study process

Results

The study sample consisted of 223 Persian and non-Persian (Arabic and Turkish) speaking girls and boys studying health information technology, speech therapy, anesthesiology, nursing, and nutrition at Isfahan University of Medical Sciences who had taken the EMP course in the first semester of the 2018-2019 academic year. Of these, 13 were excluded due to unwillingness to cooperate or due to absenteeism for more than three sessions. Table 3 indicates the demographic characteristics of the participants.

Table 3. Demographic characteristics of the study samples

Variable	Subgroup of qualitative variables	Value
n	210	210 (100)
Age (year) (mean ± SD)	21.1 ± 0.2	-
Gender [n (%)]	Female	160 (76.0)
	Male	50 (24.0)
Field of study [n (%)]	Health Information Technology	44 (21.0)
	Speech Therapy	16 (7.0)
	Anesthesia	31 (15.0)
	Nursing	61 (29.0)
	Nutrition	58 (27.5)
Mother tongue study [n (%)]	Persian	171 (81.4)
	Arabic	27 (12.8)
	Turkish	12 (5.7)
Active memory power [n (%)]	First quarter (both strong memory)	69 (32.8)
	Second quarter (strong visual memory)	58 (27.6)
	Third quarter (both poor memory)	33 (15.7)
	Fourth quarter (strong written memory)	50 (23.8)

Analysis of participants' responses to the attitude questionnaire items: The reliability of the questionnaire was obtained through the Cronbach's alpha coefficient of 0.81. Besides, the face and content validity of the questionnaire were examined by six ESP professors; Thus, the items that were approved by at least two thirds of the professors were included in the final version of the questionnaire and three items were rewritten. To some extent, all participants agreed to create learning spaces from the classroom to the simulated environment by representing real-world scenes. They believed that practicing reading content in such environments would streamline the learning and comprehension process and expand the connection between the context of teaching and learning in a wider field than in the real world. In their view, practicing English reading comprehension as a second or foreign language through games was more diverse than computer-assisted practicing in language labs.

From the participants' point of view, a learner with appropriate EMP reading skills could appear more efficiently in the field as the choices took a more correct form. Although 37.20% of the participants agreed with active role-playing in the production of game-based activities to practice reading comprehension, the participants with low levels of English reading comprehension skills (28.16%) as well as participants with visual or verbal WM impairment (36.78%) were less inclined to play an active role. At the same time, participants pointed out the problems of the widespread use of teaching and learning in reading comprehension through games. More than two-thirds of the samples rejected the use of games on the market in teaching English reading comprehension, stating that such games were a barrier to representing the true characteristics of healthcare. Hence, they emphasized their active presence in the design and production of the games.

The participants with WM deficits opposed producing game-based self-generated activities to comprehend EMP reading texts. They stated that the existence of completely new scenes in the game, on the one hand, and the novelty and complexity of EMP reading content, on the other hand, with a cognition burden, hinders learning and comprehension. The participants with high levels of visual and verbal WM were eager to participate in the production of game-based activities. They saw active participation in practice and learning as a way to better understand the psychological process, and this tendency peaked in responses of the participants with a high level of English reading skills. A significant part of the participants believed that in the present age, advances in information processing and interpretation technology have become easier. When it came to the use of a new generation of games in teaching and learning English, a significant portion of the participants with an advanced level of English reading skills as well as a high level of WM stated that simulation in this new generation of games makes it possible to understand the reading content deeply. Even the participants with poor visual or verbal WM saw participation in AR production as a window into a deeper understanding of their WM defects.

Analysis of participants' reading progress and

performance: Comparison of the participants' progress (Table 4) revealed that the WM deficit cognitive therapy through the self-generated AR and leadership in all groups, led to a better understanding of EMP reading. Meanwhile, when the circles were guided by members with high WM capacity, the rate of improvement in reading comprehension of all circle members with visual or verbal WM impairment accelerated (mean of group 7= 14.42 and leadership with strong verbal and visual WM for learners with visual WM impairment). Conversely, the least improvement occurred when learners with poor visual and verbal WM were guided by a learner with strong visual but poor WM (mean of group 2 = 11.96).

Table 4. Comparison of learners' progress in different groups

Group	Mean ± SD	95 % confidence interval	
		Lower	Upper
1	12.12 ± 0.23	11.66	12.58
2	11.96 ± 0.23	11.50	12.42
3	13.54 ± 0.23	13.08	14.00
4	12.21 ± 0.23	11.75	12.67
5	12.93 ± 0.23	12.46	13.39
6	12.88 ± 0.23	12.42	13.34
7	14.42 ± 0.24	13.95	14.89

The results of the repeated measures ANOVA test showed that there was a significant difference in the participants' reading comprehension depending on the group in which the ESP texts were practiced and their possible WM deficit was treated. Similarly, the speed of progress varied during the sessions (Table 5).

Table 5. Participants' reading comprehension progress

Source	Degree of freedom	Sum of squares	F	P value
Time × Group	27.74	3.89	7.2	< 0.001
Time	4.62	121.67	255.5	< 0.001

In this regard, when it came to the participants' performance in real-world arenas, the presence of leaders with strong verbal WM power led to successful performance. In other words, better performance was achieved with an improvement in the verbal WM level (Table 6).

There was no significant improvement in the performance of the group of participants who had poor visual and verbal WM and were guided by leaders with strong visual WM (Table 7).

Table 6. Comparison of participants' performance in the field

Group	Mean ± SD	Standard error	95 % confidence interval	
			Lower	Upper
1	11.17 ± 1.02	0.18	10.79	11.55
2	11.07 ± 1.76	0.32	10.41	11.72
3	12.93 ± 1.25	0.23	12.46	13.40
4	11.80 ± 1.12	0.20	11.38	12.22
5	13.03 ± 1.50	0.29	12.44	13.63
6	12.70 ± 1.70	0.31	12.05	13.35
7	17.10 ± 1.47	0.26	16.55	17.65

The participants' answers to the concentrated interview questions: All selected participants stated that as they practiced ESP reading comprehension, their approach to the importance of this skill changed. The learners with WM deficits clearly stated that they felt anxious about failure at the beginning of the AR-based EMP course. These participants saw no difference in the use of AR for learning English reading compared to other amateur audiovisual media when guided by leadership with only strong visual WM rather than verbal WM. The selected participants showed a favorable perception of AR-based self-generated EMP reading comprehension practice only when guided by leaders with strong visual and verbal WM. Thus, they acknowledged the constructive role of WM and cognitive therapy of this memory impairment in better understanding and performance in reading EMP texts.

Table 7. Participants' performance

Source	SS	df	Mean Squares	F	P value
Intergroup	757.16	6	126.19	60.04	< 0.001
Intra-group	426.66	203	2.10		
Total	1183.82	209			

SS: Sum of squares; Degree of freedom

The selected participants, who had reached a good reading comprehension, confirmed the usefulness of the image and text, and listed ways to improve the progress and performance of the reading comprehension, depending on the content practice using images and texts. These participants emphasized the importance of playing an active role in the production of AR-based self-generated activities, stating that by playing a role, it was possible to connect new learning with previous knowledge and create a deep understanding. For the selected participants who made progress in reading comprehension, collaboration to design and complete activities added to the effectiveness of the EMP

teaching-learning context. Conversely, the selected participants with poor visual and verbal WM, led by a learner with only strong visual memory, showed no desire to practice EMP reading content through their self-generated activities. These participants found the task of producing self-generated activities difficult and stated that the learning and reading comprehension process was slowed down. As a result, more realistic dimensions of occupational fields were conceivable. The participants stated that by combining active presence and collaboration, new responsibilities were placed on learners, which led them to constantly think about what they had learned and their reading comprehension in relation to their work environment. Once again, the success in understanding and practicing AR-based EMP reading led the selected participants to point out the usefulness of the visual and verbal dimensions of this type of self-generated reading comprehension activity. Participants with a strong WM who led the training circles spoke of their observation of the proper functioning of some individuals. According to them, the ability of their peers to solve the problem in addressing the needs of the clients in the field of health and treatment, as a result of practicing EMP reading content based on AR, was on the rise. According to these participants, the self-generated activities to practice reading comprehension helped to include reading comprehension by including useful strategies.

Discussion

The results of the present study confirmed the cognitive structure of EMP reading comprehension. Given the results, WM deficit was one of the main reasons for the unwillingness of learners to understand the ESP reading texts. Therefore, further success in the treatment of WM deficits was a step towards improving learners' reading comprehension in the context and field. The results of the present study showed that playing an active role in the production of the AR-based reading self-generated activities paves the way to understand reading for learners with poor visual and verbal WM, which in itself confirms the applicability of new generation games in higher education. In fact, WM capacity is the key to success in real life.

The results of the present study were thought-provoking from a sociosychological point of view. AR-based self-generated activity cognitive therapy helped a lot in learning and reading comprehension of learners. Through the AR-based cognitive therapy, it was possible to align the training courses with the needs of the audience. Given the findings of the present study, cognitive therapy significantly changes learning and comprehension experiences by shaping new behaviors. Moreover, these results suggested that although cognitive therapy was effective on the side of the other peers, it can take on a familiar face and significantly reduce the cognitive burden of the reading comprehension psychological stream. In fact, active involvement of learners in many cases in the practice circles of the present study led to self-discovery. Furthermore, giving learners an active role in producing self-generated educational content led to information processing skills. In this regard, cognitive therapy was easier to perform when the scenes of the AR-based activities were conducted under the guidance of peers with strong verbal and visual WM. In this way, the worries and anxieties of reading comprehension were removed from the learners; as they were able to develop reading comprehension in a collaborative effort with their peers. Thus, role-playing of the learners with positive functioning led to the improved WM deficits.

The findings of this study also indicated that the active role of learners in AR-based cognitive therapy is effective in teaching and learning EMP comprehension. Active role-playing is a type of applied analysis that makes learners know more about the psychological process of reading comprehension (29). During the production of the self-generated activities, learners with strong visual and verbal WM were able to address their counterparts with impaired WM more easily by creating a constructive interaction. Additionally, by taking the most advantage of their verbal WM, the learners were able to progress the AR-based text in line with the reading comprehension and communicate more easily with their counterparts who had a verbal WM deficit. These results can be considered as a continuation of the findings reported by Schwartz who established a connection between the writing attachment facilitators and reading comprehension skills (37).

Given the results of the present study, cognitive therapy can also be used in professional fields. In other words, the EMP reading content using the AR-based self-generated activities not only enhanced reading comprehension but also the learners' performance in the field. As a result of the production of these self-generated activities, the learners were able to use the reading content appropriately for treatment.

The strong WM of learners allowed for stronger communications in the psychological process of their reading comprehension, which facilitated the recall of reading content. These findings revealed that the visual and verbal facilitating features are as a chain;

because the AR-based content of the images and writings were complementary and not separate. At the same time, the AR-based activities made it possible to associate various psychological reading processes. With this association, new opportunities opened up for learners to look at things through new perspectives. In this way, favorable conditions were provided for learners to deal with current and future issues with sufficient skill. In this way, the learners' ability to understand tacit information is enhanced, and WM cognition therapy helps learners to go beyond their current ability in real-life areas.

All of these processes can be applied to improve the professional performance of learners. The results clearly indicated that cognitive therapy for the learners' WM deficits in EMP comprehension classes was embodied in their real-world performance. The active participation of learners in the production of the AR-based activities reduced many reading comprehension problems in the teaching-learning context and in the field. It was through the interactions formed in this application that the cognitive burden placed on the psychological process of reading comprehension was reduced. The success of learners with high WM power in guiding their peers while practicing in reading circles was largely due to the ability of these learners to create constructive interactions.

Another important conclusion from the present study was that the lack of proper understanding of the EMP reading content cannot be attributed only to the learners' WM deficits; because taking into account the results, the attitude and understanding of learners towards the application of AR in learning EMP comprehension was also effective.

Limitations

The small number of statistical samples in the present study limited the possibility of expanding the results; however, repetition of the measurements during the course helped to increase the generalizability of the results. Insufficient familiarity of the educators with new teaching technologies as digital migrants affected training and assessment in the AR-based teaching-learning context. The focus of the present study was on the treatment of WM deficits, which also led to defining leaders with strong WM to lead production circles and practice circle heterogeneity, and did not examine other contributing factors.

Recommendations

It is suggested that future studies investigate the effect of the AR-based self-generated activities on learners' comprehension and patient participation. Besides, it is better to examine other effective factors in strengthening learners' understanding and interactive ability, such as the growth of their media literacy.

Conclusion

The present study extended the horizons of AR function from the context to the field of therapy and extended the application of the AR-based self-generated activities to the WM deficit cognitive therapy. In the present study, in addition to measuring the progress and performance of the participants, their attitudes and perceptions of the training course were collected to assess the effect of AR on WM cognitive therapy.

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Authors' Contribution

Saeed Khazaie: Study design and ideation, attracting financial resources for the study, supportive, executive, and scientific study services, providing study equipment and samples, analysis and interpretation of results, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Reza Torabi: providing study equipment and samples, data collection, analysis and interpretation of results, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Abbas Saghaei: supportive, executive, and scientific study services, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments.

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Conflict of Interest

The authors declare no conflict of interest. Dr. Saeed Khazaei received funding for basic studies related to the present study from the Researchers Support Fund and the Vice Chancellor for Research of the University of Isfahan and has been working as an Assistant Professor, Department of English Language, Isfahan University of Medical Sciences since 2018. Dr. Reza Torabi is an Assistant Professor, Department of English Language, Isfahan University of Medical Sciences, and Abbas Saghaei is an MSc student, Electrical Engineering, School of Engineering, University of Isfahan.

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