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The Relationship between Working Memory, Speaking Accuracy and Length of Utterances of Iranian EFL Learners

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Abstract

This study explored the relationship among working memory (WM), speaking accuracy and length of utterance of Iranian Intermediate EFL learners. The data were collected from 38 female EFL learners whose age range was between 12 and 15 studying English at a language institute in Tehran. First, an Oxford Placement Test (OPT) was administrated to ensure the homogeneity of the participants and based on the results of the test thirty homogenous learners were selected as the main participants of the study. Next, a working memory capacity test developed by Daneman and Carpenter (1980) was administered to the participants. Later, the researcher administered a speaking test on a topic appropriate to the level of the participants which was taken from Top Notch 1 (Saslow & Ascher, 2011). Then, the researcher recorded their voices and transcribed them in order to calculate the number of lexical words the students could articulate based on a formula developed by Gilmore (2004). Speaking accuracy was also measured using a formula developed by Gilabert (2004); In fact, the students' performance was rated by two experienced teachers. Then, the Pearson correlation formula was utilized to analyze the obtained data. The results revealed a significant correlation between working memory capacity and speaking accuracy. Based on the findings, no significant correlation was shown between working memory and length of utterance. And finally, no significant correlation was depicted between length of utterance and speaking accuracy.

***Keywords*:** length of utterance, speaking accuracy, working memory

Introduction

Language is a very important and an all-purpose tool for communication and the underlying reason for this fact is people interact with each other to convey their ideas, and get feedback about others' ideas as well. Undoubtedly, one of the best and most effective ways of communication takes place through speech. Communication takes place if speech happens to show up and in case of the lack of speech, people cannot communicate competently enough (Yavuz, 2017). Accordingly, speaking is considered as an essential skill in second language learning (Celce-murcia, Brinton, & Snow, 1991). There are two crucial factors regarding speaking skill; fluency and accuracy (Harmer, 2007). Edge and Garton (2009) defined accuracy as "conforming to the language system itself," and fluency as "operating the language system quickly" (p. 15).

'Working memory' is another essential element in the process of language learning and speaking. Linck, Osthus, Koeth and Bunting (2014) indicated that working memory is completely related to the processing of L2 proficiency. Baddeley (1983) defined working memory as "The temporary storage of information in connection with the performance of other cognitive tasks such as reading, problem-solving or learning" (p. 311). Without recognizing the function of working memory, it is not still clear enough that how many performances shall be conducted in order to gather the necessary data are in mind (Case, 1995; Pascual-Leone, 1970) or how many items might be

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connected together to form a new concept (Halford, Cowan, & Andrews, 2007).

On the other hand, for evaluating someone development in language learning, one of the well-known measurement tools is the Mean Length of Utterances (MLU) which is used to measure the words in a statement. This measurement has been proved to be a useful tool in grammatical development among EFL students since increasing the length of utterance reflects the gaining of new knowledge. If a student can produce a long utterance, it shows the language competency. The length of utterance is a good marker in showing the number of the words or morphemes in each produced statement of their spontaneous utterances (Ranti, 2015).

In several studies, the relationship between working memory and speech production was represented and working memory was notified as a remarkable factor in evaluating the capability of memory to enhance the speech production (Ingvalsona, Dhar, Wong, & Liu, 2015; Lee & Redford, 2015). Also, the length of utterance has been noticed as another technique to increase the speaking accuracy and some previous studies shed light on the relationship between the length of utterance and speech production (Rice, Thompson, & Smolik, 2010; Zanjani, Karmi, & Vahab, 2014). Therefore, all these studies were conducted based on a relationship between just two variables but this investigation aims to find out any significant relationship between working memory, speaking accuracy and length of utterance to figure out any possible correlation among these three variables. Hence, in line with such issues the current study was conducted to meet three purposes which are presented through the following research questions:

RQ1: Is there any statistically significant relationship between working memory and speaking accuracy of Iranian Intermediate EFL learners?

RQ2: Is there any statistically significant relationship between working memory and length of utterances of Iranian Intermediate EFL learners?

RQ3: Is there any statistically significant relationship between speaking accuracy and length of utterances of Iranian Intermediate EFL learners?

Literature Review

Speaking

Speaking is one of the four main skills in a language which has an actual interaction in learning settings of both L1 and L2. According to a definition provided by Burns and Joyce (1997), speaking is defined as an interactive process of constructing meaning that involves producing, receiving and processing information. Its form and meaning are dependent on the context in which it occurs, the participants, and the purposes of speaking. Language learners' main worry is how to develop their speaking skill in general and in particular such as improving fluency, vocabulary, accuracy, comprehension and accent (Karimy, 2017). Brumfit (1979) suggested that fluency should be "regarded as natural language use, whether or not it results in native-speaker-like language comprehension or production" (p. 56). Accuracy refers to "the ability of the learners to produce grammatically correct sentences. Fluency and accuracy are two important elements that can represent the achievement of English learners (Hunter, 2011).

Language Sample Analysis (LSA) and Mean Length of Utterance (MLU)

A descriptive technique that is used to comprehend and evaluate learners' linguistic abilities is Language sample analysis (LSA). Language sample analysis is a descriptive technique which is used to realize and estimate the linguistic abilities of children (Suelly & Limongi, 2011). According to chamberline (2016), (LSA) is a method of childhood language assessment. Its purpose is to systematically assess, describe, and aid the clinician in understanding a child's expressive language abilities. The Mean Length Utterance (MLU) is a useful instrument that can be used for this purpose (Suelly & Limongi, 2011). Allen and Dench (2015) believed that the mean length of utterance measures the average length of a child's utterance at a given time point. It was originally developed for English and first calculated in words per utterance (Nice, 1925). In fact, "Mean length of utterance is frequently used to describe individual differences and developmental changes in linguistic proficiency" (Scarborough, Rescorla, Flusberg, Fowler, & Sudhalter, 1991, p.12).

Memory and Language Learning

In the process of language learning, memory has been shown to have vital and undeniable role. There are two broad categories of multiple systems of memory, which are, declarative memory and non-declarative memory (May, Cynthia & Einstein, 2013). According to them, 'Declarative memory' or 'explicit memory' is a memory system that is controlled consciously, intentionally, and flexibly. Declarative memory generally involves some effort and intention, and we can employ memory strategies such as mnemonics to recall information and non- declarative memory is a memory system that influences our current perceptions and behavior without our knowledge, awareness, or intention. Declarative memory has its own subsystems including; 'working memory', and 'episodic memory'.

Working memory is a short-term memory system that allows us to store and process limited amounts of information of an immediate sense. Working memory lasts anywhere from 2 to 18 seconds. This type of memory is used for mental calculations, such as figuring a tip; retaining information briefly, such as when dialing a phone number; and processing incoming information, such as when listening to a newscast. It also allows us to temporarily process information we have previously learned in a class and access it to learn and associate new information. Episodic memory, on the other hand, is a long-term memory system that stores information about specific events or episodes related to one's own life.

Non- declarative memory or implicit memory is a memory system that influences our current perceptions and behavior without our knowledge, awareness, or intention. Non- declarative memory is not used intentionally and involves no effort. It is assessed with an implicit memory test in which the individual is unaware she or he is taking a memory test.

Working Memory

According to Baddeley (1983), working memory consists of "temporary storage of information in connection with the performance of other cognitive tasks such as reading, problem-solving or learning" (p.311). It is a short-term memory system that allows us to store and process limited amounts of information of an immediate sense. Working memory lasts anywhere from 2 to 18 seconds. Juffs and Harrington (2011) believed that working memory involves both the storage and processing of information. The best known model of WM is the one first proposed by Baddeley & Hitch (1974); a later version of which from Baddeley (2000) is presented in Figure 2.1. The original model had three elements. It was comprised of two short-term storage domains consisting of the phonological loop and the visuo- spatial sketchpad and a central executive controlling the flow of information between these domains and other cognitive processes. The phonological loop controls phonological and verbal information, while the visuo-spatial sketchpad processes visual and spatial information. Later a third element, The Episodic Buffer, was added by Baddeley (2000) as the place where different types of information are temporarily stored and integrated. The three short-term storage domains are called 'slave' systems to denote their passive roles as repositories of information controlled by the central executive.

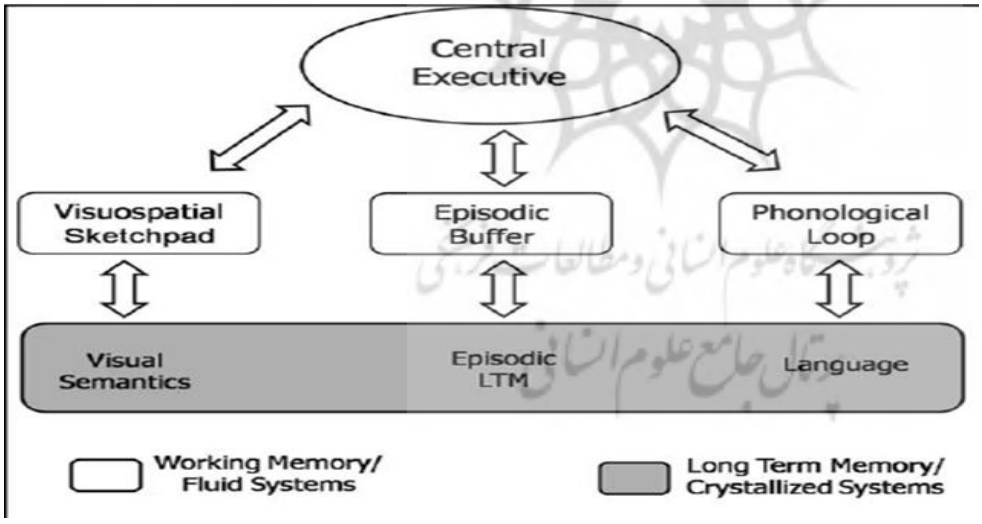

Figure 1.
The revised working memory model (Baddeley, 2000).

The short-term memory stores hold a limited amount of information that is available only for a matter of seconds before it is lost. This capacity is limited both by how much information can be maintained and how long that information is available. The processing of verbal material depends on the phonological circle and this element of it has received, from the outset, the greatest devotion from researchers interested in language learning and processing. The shaded area in Figure 2.1 represents long-term storage into which elements in the WM component above may be able to penetrate or gain access. Essentially, working memory capacity is maybe greatest thought of as a bottle-neck through which information has to

pass in order to be eternally stored in long-term memory (Juffs & Harrington, 2011).

The processing of phonological information is dominant to language learning and use, therefore, the phonological short-term memory, or Phonological Memory (PM), is of central importance. In Baddeley's model PM is controlled by the phonological loop, and this element has been expected to play a vital role in L1 development (Baddeley 1999). PM is in charge of the processing and temporary retention of both familiar and novel phonological information. From the outset, the role of PM in the acquisition of new words has been stressed. In addition to L1 vocabulary learning, PM has also been related to spoken language development more generally. Children, with greater PM capacity, produce utterances with greater length and narratives of increased grammatical and semantic complexity than their lower capacity counterparts (Adams & Gathercole 1996).

Working Memory Measurement

There are many ways to measure working memory. It is defined by both storage and processing components, which can be estimated discretely or in combination (Juffs & Harrington, 2011). Simple short-term storage capacity is typically measured by the number or span of unrelated digits or words that can be recalled. Processing capability is estimated by using tasks that make simultaneous demands on storage and processing, sometimes referred to as complex working memory (Colom, Shih, Flores-Mendoza & Quiroga, 2006).

Some researchers have chosen to use measures that ask participants to repeat phrases or sentences of increasing difficulty. For example, Lesaux, Lipka and Siegel (2006) used the Stanford Binet Memory for Sentences subtest where sentences to repeat began simple (Drink milk) to more complex (Ruth fell in a puddle and got her clothes all muddy). Another working memory measure is to present participants with sentences with the final word missing. Participants are then asked to produce the missing word in each sentence and then repeat the missing words of all the sentences in the section, demonstrating their ability to hold information in working memory (Abu-Rabia & Siegel, 2002; Babayigit, 2015; Lesaux, Lipka, & Siegel, 2006; Lesaux & Siegel, 2003; Lipka & Siegel, 2011; Low & Siegel, 2005).

In a similar version of this test, participants are first presented aurally with all the sentences in each section and are asked to judge if they are grammatical or ungrammatical, this is done in an effort to ensure that learners pay attention to the context of the sentence and are not simply memorizing the words. Participants are then presented with the sentences a second time, this time with the final word missing and must supply the missing word through memory. Example sentences include: "The only thing left in the kitchen cupboard was a broken cup, and, I dreamed that I was in with field a sheep" (Alptekin & Ercetin, 2010).

Another method of testing working memory is to present participants with groups of words which they must remember all of the words in each group in order to provide the opposite to the words. For example, the participants 18 may be presented with the two words: good, down and are then expected to produce the words: bad, up (Gholamain & Geva, 1999).

Method

Participants

The participants were 38 EFL female students whose age range was between 12 and 15. They were studying at intermediate level in Fatima language institute in Shahr-e-Qods. After administering an Oxford Placement Test (OPT), thirty homogenous learners whose scores were one standard deviation below and above the mean were selected as the main participants of the study.

Instruments

In order to gather data, an Oxford Placement Test (OPT) was administrated to ensure the homogeneity of the participants and based on the results of the test thirty homogenous learners were selected as the main participants of the study. Also, a working memory capacity test developed by Daneman and Carpenter (1980) was administered to the participants. Later, the researcher administered a speaking test on a topic appropriate to the level of the participants which was taken from Top Notch 1 (Saslow & Ascher, 2011).

Procedure

The current study was carried out with the help of three types of data collection instruments including a general English proficiency test that was Oxford Placement Tests (OPT) (Version 2), a Reading-Span Test (RST) and an audio recorder. An OPT was used to select the participants at intermediate level for the study; a reading-span test , was used to measure the participants' working memory capacity (Daneman and Carpenter, 1980); and the audio recorder, in order to record students' speaking and then replay the voices to be heard and transcribed into written forms.

After administrating the OPT, eight participants were excluded from the study and thirty homogenous

learners whose scores were one standard deviation below and above the mean were selected as the main participants in the study. Then in order to measure the participants' working memory capacity, RST; developed by Daneman and Carpenter (1980), was administrated. This test contained 27 sentences that were ended up with different words and their length was between ten and fifteen words. The sentences were divided into six sections and each section included 2 to 7 sentences which were increased in number section by section. After reading each sentence, participants should have determined whether the sentence was semantically correct or not and put a mark on the answer sheet. When they came up to the end of each section, they were asked to recall the last words of each sentence respectively in sixty seconds and wrote them down on their answer sheets. One point was considered for each correct answer in both processing and storage stages. This test lasted about thirty minutes and the researcher collected students' answer sheets and rated them carefully based on the special formula developed by Daneman and Carpenter (1980) as well as Daneman and Tradif (1987). The students' scores were obtained out of the mean of these two scores and calculated out of 27. The result was expressed as a percentage.

In the next step, the researcher aimed to measure participants' speaking accuracy and their length of utterances. A topic about the family relationship was selected from Top Notch 1 (Saslow & Ascher, 2011). This activity consisted of a narrative monologue based on the selective topic. Then the researcher recorded the first three minutes of participants' speech samples and transcribed them in written form. These written texts were rated by two professional and experienced raters who were graduated at M.A. level in English language teaching and they have had more than ten years of experience in teaching. Furthermore, for measuring speaking accuracy, the researcher applied a measure based on T-units. As Mehrang and Rahimpour (2010) asserted, "T-units contain main clauses as well as subordinate clauses attached to or embedded in them and error-free T-units are defined as only those correct T-units in terms of grammar, syntax, vocabulary, and spelling" (p.12). So, all the main clauses plus subordinate clauses attached to or embedded in were counted as T-units. The T-units which contained no syntactic, grammatical, lexical or spelling errors were considered as error-free T-units. In order to estimate the participants' accuracy, the number of error-free T-units, were divided by the total number of t-units (Gilabert, 2004).

For calculating length of utterance, Gilmore (2004) presented a formula. Based on what he contended, the length of utterance calculations assume that all words fall into two categories: a lexical group made up words which have independent sense; for example, "mother" and a grammatical group consisting of words devoid of independent meaning; for instance, "a". Length of utterance is shown by a percentage of lexical words within a text following the formula: 100 L/T, where L is the number of lexical words and T is the number of words in the text.

Data Analysis

The present study dealt with quantitative measures of data collection and descriptive analysis.

After the raters scored participants' speaking accuracy and length of utterance by implementing different formulas and indexes, the scores were analyzed through SPSS using Pearson Correlation formula to discover any possible relationship among them. The present research savored a correlational research design. None of the variables of the study were manipulated to cause changes. The paramount importance was the type and strength of the correlation between variables of the study; thus, a correlational research design was the appropriate one for the accomplishment of the purpose of the study (Field, 2013).

Findings

First of all, the participants took part in an OPT to be homogenized and then. The number of participants who participated in this test was 38 intermediate learners and Table 1 shows the mean and standard deviation.

Table 1.
The OPT Result

	N	Minimum	Maximum	Mean	Std. Deviation
OPT TEST	38	15.00	58.00	27.84	8.07675
Valid N (listwise)	38				

According to the result of the OPT (*M=27.84* and *Std.=8.076*), thirty students whose score ranged between one standard deviation above and below the mean were selected.

Testing Normality Assumption

The null-hypotheses raised in this study were analyzed using Pearson correlations which assumes normality of the data. Table 2 displays the values of the skewness and kurtosis statistics and their ratios over the standard errors. Since the absolute values of the ratios were lower than 1.96, it can be concluded that the assumption of normality was retained.

Table 2.
Descriptive Statistics; Testing Normality of Data

	N	Skewness			Kurtosis		
	Statistic	Statistic	Std. Error	Ratio	Statistic	Std. Error	Ratio
Working	30	.551	.427	1.29	-.745	.833	-0.89
Length	30	-.187	.427	-0.44	-.554	.833	-0.67
Accuracy	30	.169	.427	0.40	.166	.833	0.20

KR-21 Reliability Index of Working Memory

Table 3 displays the descriptive statistics and KR-21 reliability index of the working memory. The results showed that working memory enjoyed a reliability index of .82.

Table 3.
Descriptive Statistics and KR-21 Reliability of Working Memory

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Working	30	10	27	17.13	5.412	29.292
KR-21	.82					

Inter-Rater Reliability Indices of Speaking Accuracy and Length of Utterances

Table 4 displays the results of the Pearson correlations computed in order to probe the inter-rater reliability indices of speaking accuracy and length of utterances. The results showed that there were significant agreements between the two raters on length of utterances (r (28) = .89 representing a large effect size, p = .000) and speaking utterances (r (28) = .94 representing a large effect size, p = .000).

Table 4.
Pearson Correlations; Inter-Rater Reliability of Speaking Accuracy and Length of Utterances

		Length of Utterances Rater 2	Speaking Accuracy Rater2
Length of Utterances Rater 1	Pearson Correlation	.893**	
	Sig. (2-tailed)	.000	
	N	30	
Speaking Accuracy Rater 1	Pearson Correlation		.944**
	Sig. (2-tailed)		.000
	N		30
****. Correlation is significant at the 0.01 level (2-tailed).**			

Exploring the First Null-Hypothesis

The first null-hypothesis postulated that there was not any statistically significant relationship between working memory and speaking accuracy. Table 5 displays the results of the Pearson correlation calculated to probe any significant relationship between the two variables. Based on these results (r (28) = .547 representing a large effect size, p = .002) it can be concluded that there was a significant

relationship between the two variables. Thus the first null-hypothesis as "there was not any statistically significant relationship between working memory and speaking accuracy of Iranian Intermediate EFL learners" was rejected.

Table 5.
Pearson Correlation between Working Memory and Speaking Accuracy

		Speaking Accuracy
Working Memory	Pearson Correlation	.547**
	Sig. (2-tailed)	.002
	N	30

****. Correlation is significant at the 0.01 level (2-tailed).**

Exploring the Second Null-Hypothesis

The second null-hypothesis stated that there was not any statistically significant relationship between working memory and length of utterances. Table 6 displays the results of the Pearson correlation calculated to probe any significant relationship between the two variables. Based on these results (r (28) = -.400 representing a moderate effect size, p = .028) it can be concluded that there was a negative and moderate relationship between working memory and length of utterances. Thus the second null-hypothesis as "there was not any statistically significant relationship between working memory and length of utterances of Iranian Intermediate EFL learners". was rejected.

Table 6.
Pearson Correlation between Working Memory and Length of Utterances

		Length of Utterances
Working Memory	Pearson Correlation	-.400**
	Sig. (2-tailed)	.028
	N	30

****. Correlation is significant at the 0.01 level (2-tailed).**

Exploring the third Null-Hypothesis

The last null-hypothesis stated that there was not any statistically significant relationship between speaking accuracy and length of utterances. Table 7 displays the results of the Pearson correlation calculated to probe any significant relationship between the two variables. Based on these results (r (28) = -.332 representing a moderate effect size, p = .073) it can be concluded that there was a negative and non-significant relationship between speaking accuracy and length of utterances. Thus the fourth null-hypothesis as "there was not any statistically significant relationship between speaking accuracy and length of utterances of Iranian Intermediate EFL learners" was supported.

Table 7.
Pearson Correlation between Speaking Accuracy and Length of Utterances

		Length of Utterances
Speaking Accuracy	Pearson Correlation	-.332
	Sig. (2-tailed)	.073
	N	30

Discussion and Conclusion

The statistical analysis of collected data revealed a significant relationship between working memory capacity and speaking accuracy. In addition, there was a moderate and negative relationship between the working memory and length of utterances. Finally, the result stated that there was not any statistically significant relationship between speaking accuracy and length of utterances.

The result of the research conducted by Mizera (2006) is in contrast with the findings of the current study. He examined the relationship between working memory and L2 oral fluency. In the main experiment, 44 native English speakers who were studying Spanish as a foreign language were tested with a set of three working memory tests, and the scores from these tests were correlated with the scores of three L2 oral fluency tests. The hypothesized strong correlations between working memory capacity and fluency were not found. Furthermore, many of the working memory scores did not correlate strongly with each other. He speculated these negative results refer to the complex nature of speaking in a foreign language, which may tax other faculties more than working memory.

On the other hand, Rezai and Okhovat (2016) investigated the effect of working memory on EFL learners' oral fluency and their finding is in line with that of the present study. In other words, the statistical findings revealed that working memory, as a cognitive factor, played a significant role in L2 oral fluency accounting for variation in L2 performance. This study offered some implications regarding to strategies to improve learners' both fluency and working memory.

In addition, Mota, (2003) investigated whether there was a relationship between working memory capacity and L2 speech production. Her findings are in parallel with this research. Statistical analyses revealed that working memory capacity, as measured by the speaking span test, correlates positively with fluency, accuracy, and complexity, as predicted. Moreover, Wen (2012) did an empirical study investigating the

differential effects of WM constructs on L2 task-based speech planning and performance, culminating in forged links bridging WM components and their corresponding L2 speech performance measures. Further implications of this integrated framework of WM for SLA are also discussed in the context of "WM as foreign language aptitude" (p.1).

Unlike the findings of the present study which working memory capacity and L2 length of utterance did not have any correlation with each other, the relationship between working memory and first language length of utterance has been proved by many studies (Rice, Thompson, &Smolik, 2010; Zanjani, Karmi, and Vahab ,2014). It seems in this relationship, other factors like cognitive development and age could be effective (Gatherocole & Baddeley, 1993).

The current study has sought to understand the relationship between working memory, speaking accuracy and length of utterances of Iranian Intermediate EFL learners. The results of statistical analysis showed a significant correlation between working memory capacity and speaking accuracy, no significant correlation between working memory and length of utterance, and no significant correlation between length of utterance and speaking accuracy.

Accordingly, those Iranian EFL learners who enjoy more working memory capacity may be more successful in accurate speaking, whereas the length of utterance would not be in relation with speaking accuracy, or working memory capacity.

The results of this study can be useful for some stakeholders in EFL contexts. In other words, teacher, learners, teacher trainers, and materials developer and syllabus designers could benefit from the present research findings. The EFL learners are the first group who benefit from the results of this study. In applying different tasks and activities to support and reinforce the working memory capacity, they can be guaranteed to be more successful in L2 speaking accuracy. EFL teachers are the second group who can benefit from the results of this study. In order to aid their learners to be more successful L2 speakers, they should use and adopt different activities and tasks to develop the learners' working memory capacity in speaking classrooms.

Teacher trainers can also benefit from the results of this study. They can introduce different methods, strategies, activities, and tasks to pre-service EFL teachers how to develop the learners' working memory capacity for speaking classrooms. Material developers who are designing different material for EFL/ESL learners are the next group. They need to consider the findings of this study in the development of required materials to propose different activities and strategies to enhance working memory capacity of learners in L2 learning materials in general, and speaking as particular.

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