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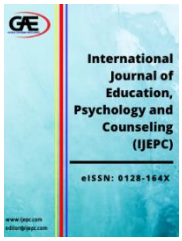

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EXPLORING THE INFLUENCE OF CENTRAL EXECUTIVE ON MEMORY DURING LEARNING AMONG UNDERGRADUATES

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Abstract:

The process of change from schools to higher institutions can be challenging to some undergraduates. They may feel overwhelmed with new information and how to store them in their memory. Some are able to recall information even from distant past because they are able to store the information in their memory. Memory is important for learning because it acts as a storage system for the attained knowledge. There are several types of memory. Upon first encounter with the information, a person stores it immediately in the sensory memory. If the information is properly stored, it gets transferred to the long-term memory storage. This quantitative study explores undergraduates' perception on their use of memory for learning. A purposive sample of 113 participants responded to the survey. The instrument used is a 5 Likert-scale survey. The survey has 4 sections. Section A has items on demographic profile. Section B has 6 items on sensory memory. Section C has 13 items on central executive and section D has 6 items on long-term memory. Analysis of findings reveal is also a strong positive relationship between sensory memory and central executive. Findings also has shown that there is also a strong positive relationship between central executive and long-term memory. This means that learners are aware that information that is temporarily stored will be transferred to the central executive. In the classroom setting, This transfer process is influenced by activities carefully planned by the instructor. The success of these activities will then affect the transfer of the information to learners' long-term memory. The findings of this study bear interesting implications on how teachers can better understand how learners store information in order to maximise learning.

Keywords:

Undergraduates, Sensory Memory, Central Executive, Long-Term Memory, Learning

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Introduction

Ever wondered why we do not remember information easily or maybe even why we can retrieve information that was stored sometime back? The ability and capacity to retrieve information is enabled by the use of memory. There are many types of memory. One type that is very brief is the sensory memory and this type stores information from the five senses. Next, the short-term memory is also known as the primary of active memory. Just like the sensory memory, this type of memory allows information to be stored for a short-time. The long-term memory is able to store information for lasting period of time. The working memory stores information that is constantly manipulated for processing. According to Forsberg,et. al. (2021), the working memory ability is related to learners' educational attainment. Baddeley & Hitch (1974), presented the working memory model that states the presence of the central executive which acts as the control system that manages the storing of information. The control systems include (a) visuospatial sketchpad and (b) phonological loop, articulatory control and phonological store.

Memory is important for learning because it acts as a storage system for the attained knowledge. Shen & Park (2020) felt that one factor that facilitates memory storage is that the information is stored in chunks. Having memory allows a person retains information for future use and future learning. Nevertheless, often learners are not able to story information in their memory long enough for the next use. What happens to the information once it is acquired by the learners? Is the memory stored temporarily (sensory memory) or kept for long-term use? What factors influence the central executive so information stays? This study explores how learners use their sensory memory, central executive and also long-term memory. In addition to that, Phuroc & Nguyen (2024) suggested that future researchers examine the relationship between short-term memory, long-term memory and what factors influence the storage of memory. Hence this study also looks at the relationship between central executive with sensory memory and long-term memory. Specifically, this study is done to answer the following questions;

- How do learners perceive their use of sensory memory?
- How do learners perceive their use of central executive memory?
- How do learners perceive their use of long-term memory?
- Is there a relationship between all types of memory?

Literature Review

This section presents the theoretical framework of the study, past studies and the proposed conceptual framework of the study.

Theoretical Framework

This study is framed on several theories about (i) factors that impede memory storage and (ii) the working memory. The discussion of (i) and (ii) would lead to a better understanding of (iii) how learners learn.

Factors That Impede Memory Storage

Several factors can lead to the failure of memory storage. The laymen would see this situation as forgetting information. This can happen due to several reasons. Experts explains this ability to forget through some theories. This section elaborates (a) the displacement theory of

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forgetting, (b) the retrieval failure theory of forgetting, (c) the trace decay theory of forgetting and (d) the concept of interference.

The Displacement Theory of Forgetting

This theory is introduced by Waugh & Norman (1965). This is an interesting theory that states that people forget information because they have limited capacity in their memory in which the new information they have received replaces the older information already stored in their memory.

The Retrieval Failure Theory of Forgetting (Tulving & Thomson,1973)

According to Tulving & Thomson (1973), the retrieval failure theory of forgetting states that a person forgets because he/she needs cues to retrieve the information they stored in their memory. So, based on this theory a person needs to find the right key to "unlock their memory".

The Trace Decay Theory Of Forgetting

This classic theory was introduced by Thorndike (1905). This interesting theory states that a person's memory fades away as time goes by. This is because the person does not access to the information regularly. Memory retrieval also is determined by the time between the information was first stored and the time the person decide to recall it. This means the sooner the person attempts to recall the information after it was stored, the better.

The Concept of Interference

Rubio Rodriguez (2024) states that sometimes a person has difficulty recalling something because the recall is intervened by previously stored and new information. He states when old memories interfere with new information that is called proactive interference. Interestingly, when old memory is altered by new information, that is known as retroactive interference.

The Working Memory

In order to forget the information, our brain develops the working memory. The working memory reveals the information processing that people go through in learning.

Unsworth & Engle (2007) suggest that some people with low working memory capacities need to improve on two main components in their information storage. The first one is the primary memory or also known as dynamic attention. The second is the secondary memory or probabilistic cue-dependent attention. The former requires people to focus their attention on the information attained while the latter suggests that people use cues to retrieve stored information.

Another theory on working memory is presented by Baddeley & Hitch (1974). With reference to figure 1, the working memory is basically managed by the central executive. The central executive is responsible for cognitive tasks of the person. Firstly, the person receives Input and this Input goes through the sensory memory. This means the information is momentarily captured (remembered) by the person. It is easily forgotten if no Attention is given to the information. However, if Attention is given, the information arrives at the Central Executive for storage.

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The Central Executive (look at the double-sided arrows) needs Visuospatial Sketchpad and Phonological Loop, Articulatory Control and Phonological Store to enhance information storage. Visuospatial Sketchpad refer to information that is presented in the form of visual together with the spatial space. Next, Phonological Loop, Articulatory Control and Phonological Store refer to information that is speech-based and the articulatory process. Finally, the elements in the Central Executive promotes and eases the information to be retained in the Long-Term Memory (LTM).

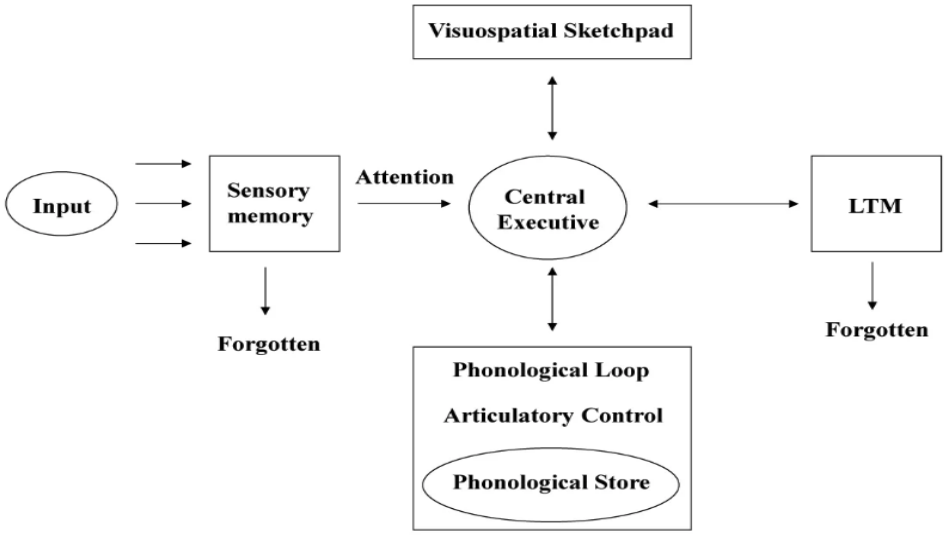

Figure 1- Working Memory (Baddeley & Hitch, 1974)

How Learners Learn

Learning is an action where leaners are given information to process. This process requires the learner to use stored information in their memory to make sense of the new information. According to Saba and Balwan (2021), memory essential for learning. Information that is stored need to be linked to new knowledge to facilitate storing. Saba and Balwan (2021) state that there is a symbiotic relationship between the elements in memory.

Next, Shmavonyan and Karapetyan (2011) found that memory is a source of knowledge and is a continuous process. The process is considered continuous because the new information needs to make sense in the memory. To make sense, previously stored information can provide familiarity to the new information. Shmavonyan and Karapetyan (2011) suggest several strategies to enhance learners' memory and they are;

(a) Concentrating students' attention
(b) Establishing regular study sessions
(c) Structuring and organizing the material under study
(d) Associating the new information to familiar things
(e) Visualizing the material being studied
(f) Over-learn the new information
(g) Active reding
(h) Engage in retrieval practice
(i) Priming the memory prior to learning
(j) Review the material

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Past Studies

Past Studies On The Use Of Memory For Learning

A quantitative study was conducted by Sims and Rahmat (2024) to explore information processing of learners studying Mandarin. 30 participants were chosen for the study. The instrument used was a questionnaire using a 5-Likert scale with items about sensory, short-term memory, long-term-memory, working memory. Respondents gave positive feedback on their perception of various types of memory when learning Mandarin. Findings revealed that learners perceive the use of short and long-term memory in their language learning.

Next a quantitative study was done by Phuroc & Nguyen (2024) to examine the relationship between short-term memory and interpretative skills. The participants were English linguistics final-year students from Ho Chi Minh City University of Industry and Trade's (HUIT). The study examined how students use short-term memories to influence their interpretation in language learning. Findings from correlation studies and regression models reveal interesting discovery. The study showed that learners used short-term memory for comprehension. They understood better using short-term memory. Participants reported that they processed language faster, recalled better, and grasped verbal intricacies using short-term memory.

Finally, Nwagwu and Donkor (2022) explored the personal information (PIM) system faced by a faculty in six universities in Ghana. This quantitative study employed a survey as the instrument. The participants were 235 faculty members. Findings showed that there are two sub-functions of refinding which includes self-confidence and memory. Findings also found that there were no significant multivariate effects for gender. However, there were significant effects for age and use of memory.

A qualitative study was done by Hojjati (2022) to investigate the relationship between memory and students' language learning. Library resources and related articles were used as data. Findings revealed that language learners who have strong short-term memory (both visual and written) have good performance in learning vocabulary. Learners with strong visual short-term memory but poor verbal short-term with poor visual short-term memory and good verbal short-term memory performed well in language learning. The implication of the study is that the teaching and learning of language needs recall activities to enhance learners' memory.

Conceptual Framework

Figure 2 shows the conceptual framework of the study. The framework of this study is based on Saba and Balwan's (2021) concept of symbiotic relationship between the elements in the working memory. According to Baddeley & Hitch (1974), the working memory comprises of the sensory memory, central executive and long-term memory. Learning begins when the learner received new information. The immediate response to the new information is that it (the information) stays first in the sensory memory. In the context of this study, sensory memory is measured by how learners perceive their immediate understanding of new information/concepts heard, seen or touched.

Through learning tasks, the new information can proceed to enter the central executive. However, this is dependent on two main elements; the visuospatial sketch pad and phonological loop, articulatory and phonological store. Visual sketch pad refers to information that involves

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visual and spatial. Next, phonological loop, articulatory and phonological store refer to verbal information that is spoken or heard.

Through successful storage in the central executive, the new information can now stay in the long-term memory by the learner to be retrieved as and when needed. Hence, this study explores whether there is a relationship between sensory memory and central executive as well as central executive and long-term memory.

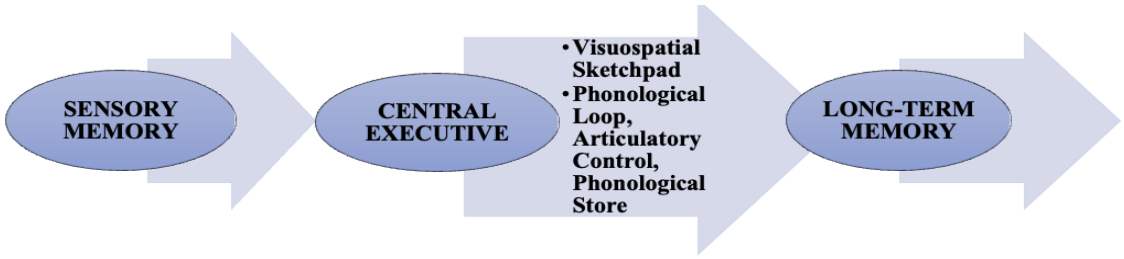

Figure 2- Conceptual Framework Of The Study
The Relationship Between Types Of Memory

Methodology

This quantitative study is done to explore the perception of working memory for among undergraduates from a public university in Malaysia. They are students in their early semesters just embarking on their higher institution learning. A simple random sample of 113 participants responded to the survey. This is done by the researcher choosing the participants who bets fit this study needs. The instrument used is a 5 Likert-scale survey and is rooted from Baddeley & Hitch (1974) to reveal the variables in table 1 below. The survey has 4 sections. Section A has items on demographic profile. Section B has 6 items on sensory memory. Section C has 13 items on central executive and section D has 6 items on long-term memory.

Table 1-Distribution of Items in the Survey

SECTION	WORKING MEMORY	TYPE OF INFORMATION PROCESSING	NO OF ITEMS	ALL ITEMS	CRONBACH ALPHA
B	SENSORY			6	.974
C	CENTRAL EXECUTIVE	VISUOSPATIAL SKETCHPAD	4	13	.927
		PHONOLOGICAL LOOP, ARTICULATORY CONTROL & PHONOLOGICAL STORE	9		
D	LONG-TERM			6	.960
			25		.964

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Table 1 also shows the reliability of the survey. The analysis shows a Cronbach alpha of .974 for Sensory memory, .927 for Central Executive memory and .960 for Long-term memory. The overall external validity for all 25 item is .964; thus, revealing a good reliability of the instrument used. Further analysis using SPSS is done to present findings to answer the research questions for this study.

Findings

The presentation of findings for this study is first focused on the demographic profile and then towards answering individual research questions presented in the introduction above.

Findings for Demographic Profile

Table 2- Percentage for Gender

NO	ITEM	PERCENTAGE
1	Male	49%
2	Female	51%

Table 2 shows the percentage for gender of the participants. 49% of the participants are male while 51% are female.

Table 3- Percentage for Discipline

NO	ITEM	PERCENTAGE
1	Science & Technology	63%
2	Non-Sciences	37%

Table 3 presents the percentage for discipline. 63% of the participants comprise of science & technology discipline. 37% of the participants were studying non-sciences courses.

Findings for Sensory Memory

This section presents data to answer research question 1- How do learners perceive their use of sensory memory?

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Table 4- -Mean for SENSORY MEMORY

NO	ITEM	MEAN	SD
1	I understand new words immediately when I HEAR it being said	3.5	.87754
2	I remember new words immediately after I HEAR it	3.5	.83528
3	When I SEE new words for the first time, I try to understand it	4.1	.717644
4	When I SEE new words in for the first time, I try to remember it	4	.71289
5	After learning new words, I will use it in my communication	3.8	.97155
6	I can remember better things if I can TOUCH them	4	.85037

Table 4 shows the mean for sensory memory. The highest mean if 4.1 for the item "When I SEE new words for the first time, I try to understand it". Two items share the mean of 4 and they are "When I SEE new words in for the first time, I try to remember it" and "I can remember better things if I can TOUCH them". The lowest mean is 3.5 for two items; "understand new words immediately when I HEAR it being said "remember new words immediately after I HEAR it".

Findings for Central Executive

This section presents data to answer research question 2- How do learners perceive their use of central executive memory? In the context of this study, this is measure by (i) visuospatial sketchpad and (ii) phonological loop, articulatory control & phonological store.

Table 5 Mean for (i) VISUOSPATIAL SKETCHPAD

NO	ITEM	MEAN	SD
1	I can recall different locations of objects	3.8	.82968
2	I can recall different relationships of information given to me	3.7	.92659
3	I can remember the faces of people I have seen only once	3.5	1.10252
4	I can remember specific details about objects, building or places	3.7	.91094

Table 5 presents the mean for visuospatial sketchpad. The highest mean is 3.8 for the item "recall different locations of objects". Two items share the same mean of 3.7 and they are "recall different relationships of information given to me" and "remember specific details about objects, building or places". The lowest mean is 3.5 for the item "remember the faces of people I have seen only once".

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Table 6- Mean for (ii) PHONOLOGICAL LOOP, ARTICULATORY CONTROL & PHONOLOGICAL STORE

NO	ITEM	MEAN	SD
1	I am able to REMEMBER how to pronounce a new word after I hear it	3.7	.82462
2	I am able to REPEAT how to pronounce a new word after I hear it	3.9	.67929
3	I can direct my attention when I need to	4	.79495
4	I can maintain my task goal when I am working	3.8	.80424
5	I am able to organize, plan and carry out my tasks efficiently	3.7	.8093
6	When I want to remember anything, I try to recall what they look like	4	.74868
7	When I want to remember anything, I try to recall the location of the object	3.9	.71654
8	I can easily remember words I hear	3.8	.76259
9	I can easily repeat words I have heard	3.9	.79625

Table 6 shows the mean for phonological loop, articulatory control & phonological store. The highest mean is 4 for two items and they are “direct my attention when I need to” and “want to remember anything, I try to recall what they look like”. Next, three items share the same mean of 3.9 and they are “able to REPEAT how to pronounce a new word after I hear it”, “want to remember anything, I try to recall the location of the object” and “easily repeat words I have heard”. Two items share the lowest mean of 3.7 and they are “REMEMBER how to pronounce a new word after I hear it” and “organize, plan and carry out my tasks efficiently”.

Findings for Long-Term Memory

This section presents data to answer research question 3- How do learners perceive their use of long-term memory?

Table 7- Mean for LONG-TERM MEMORY

NO	ITEM	MEAN	SD
1	I can remember information about recent past events	3.7	.86685
2	I can remember information about recent or past experience	3.9	.80973
3	I easily recall words and their meaning	3.6	.82720
4	I easily recall facts about the things around me	3.6	.81197
5	I easily recall information that I have memorized	3.7	.80670
6	I can easily recall how things are done	3.8	.75425

Table 7 presents the mean for long-term memory. The highest mean is 3.9 for the item “remember information about recent or past experience”. Next, the item “easily recall how things are done” has a mean of 3.8. Two items share the lowest mean of 3.6 and they are “recall words and their meaning” and “recall facts about the things around me”.

Findings for Relationship for all types of Memory

This section presents data to answer research question 4- Is there a relationship between all types of memory? To determine if there is a significant association in the mean scores between all types of memory, data is anlaysed using SPSS for correlations. Results are presented separately in table 8 and 9 below.

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Table 8- Correlation Between Sensory And Central Executive

		SENSORY	CENTRAL EXECUTIVE
SENSORY	Pearson Correlation	1	.888**
	Sig.(2-tailed)		.000
	N	113	113
CENTRAL EXECUTIVE	Pearson Correlation	.888**	1
	Sig.(2-tailed)	.000	
	N	113	113

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

Table 8 shows there is an association between sensory memory and central executive. Correlation analysis shows that there is a high significant association between sensory memory and central executive (r=.888**) and (p=.000). According to Jackson (2015), coefficient is significant at the .05 level and positive correlation is measured on a 0.1 to 1.0 scale. Weak positive correlation would be in the range of 0.1 to 0.3, moderate positive correlation from 0.3 to 0.5, and strong positive correlation from 0.5 to 1.0. This means that there is also a strong positive relationship between sensory memory and central executive.

Table 9-CORRELATION BETWEEN CENTRAL EXECUTIVE AND LONG-TERM MEMORY

		CENTRAL EXECUTIVE	LONG-TERM
CENTRAL EXECUTIVE	Pearson Correlation	1	.865**
	Sig.(2-tailed)		.000
	N	113	113
LONG-TERM	Pearson Correlation	.865**	1
	Sig.(2-tailed)	.000	
	N	113	113

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

Table 9 shows there is an association between central executive and long-term memory. Correlation analysis shows that there is a high significant association between central executive and long-term memory (r=.865**) and (p=.000). According to Jackson (2015), coefficient is significant at the .05 level and positive correlation is measured on a 0.1 to 1.0 scale. Weak positive correlation would be in the range of 0.1 to 0.3, moderate positive correlation from 0.3 to 0.5, and strong positive correlation from 0.5 to 1.0. This means that there is also a strong positive relationship between central executive and long-term memory.

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Conclusion

Summary of Findings and Discussions

Overall, findings in this study has shown that learners depend on their use of memory to learn. Sensory memory is used at the initial stage of learning for learners to capture the information at a glance. Phuroc & Nguyen (2024) also found that students use short-term memories to influence their make meaning.

Next, memory storage is further enhanced when information is transferred to the central executive. Learners benefit from learning tasks that encourage the use of visual, spatial, and even auditory means. These means can further allow the memory to be stored in long-term storage. Shmavonyan and Karapetyan (2011) found that memory is a source of knowledge and is a continuous process. When learners participate in activities that encourage further memory storage, there is a high chance that the information is transferred into long-term storage. Old information stored in the memory make learners decode incoming new information through familiarity. The process is considered continuous because the new information needs to make sense in the memory.

With reference to figure 2 below, data analysis for this study has confirmed that the initial conceptual framework presented is proven to be true.

Figure 2- Conceptual Framework of the Study
The Relationship between all Types of Memory

Analysis of findings reveal is also a strong positive relationship between sensory memory and central executive. Findings also has shown that there is also a strong positive relationship between central executive and long-term memory. This study is thus in accordance with Saba and Balwan's (2021) concept of symbiotic relationship between the elements in the working memory. In addition to that, the findings in this study also can respond to Phuroc & Nguyen's (2024) initial suggestion for researchers to examine the relationship between short-term memory and interpretative skills (different forms of memory).

To sum up, in the context of this study, there is a positive relationship between all three types of memory discussed. This means that learners are aware that information that is temporarily stored will be transferred to the central executive. In the classroom setting, this transfer process is influenced by activities carefully planned by the instructor. The success of these activities will affect the transfer of the information to learners' long-term memory.

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Pedagogical Implications and Suggestions for Future Research

As teachers, we cannot assume what is taught is learnt by our students. Imparting knowledge on the part of the teacher may seem like only one part of teaching. The teacher's responsibility includes helping students transfer the knowledge into their long-term memory for future use. Learning activities should also include guiding students to store the new knowledge into their long-term memory. These activities could also include guiding students retrieve information recently taught for usage and future learning.

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