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DOES MIND MAPPING ENHANCE LEARNING?

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ABSTRACT: *In a setting whereby, students of the English Department at the College of Basic Education are exposed to course materials across a number of courses, in a language other than their mother tongue, requiring them to read, comprehend and analyse, note taking gets extremely complicated. The current study focuses on such a complex dilemma, with its objective to find out whether mind mapping may successfully be used by our students in order to overcome their linguistic problems. For the purpose, fifty third/fourth year English language students were used as the study's sample. The students were divided into two groups and trained to use two different note taking techniques. Later they were given a 10 MSCs, each followed by subjective response question: know, remember, guess. In addition, students were asked to write about their experience to obtain qualitative data. Findings of the study suggest a higher level of performance when the students learn their study material using MM as opposed to SNT. More positive attitudes in favour of MM were also elicited from their selection between the three responses (Know, Remember & Guess).*

KEYWORDS: Standard Note Technique (SNT), Mind Map (MM), EFL, Higher Education, Long-Term Memory, Short-Term Memory, Attitudes, Performance.

INTRODUCTION

The ultimate goal of the educators worldwide is to enhance learning, assist learners to learn better, develop their cognitive abilities, and provide them with techniques that help them to retain information for as long as possible. At a much higher level, educators would also seek creativity. As we are living in an era of technological inventions and development, educators have also sought tools that might aid both teachers and students to learn faster, and at a higher level of efficiency and stability. One of the most prevalent techniques that our students use to enhance learning and understanding is transformation of the presented material into a written transcription, a process that requires the ability to identify major ideas, establish relationships, understand the medium of communication, decode the meaning, and encode the information in the learner's own words (Ehindero, 2000). Such a complex process gets even more complicated in a context where the medium of instruction is different from the learners' mother tongue. Students of the English department at the College of Basic Education, whose mother tongue is Arabic, are faced with such a complex dilemma, in particular, when they attend the course of Psycholinguistics, in which they are introduced to extremely complex terms, concepts and theories that require highly sophisticated linguistic proficiency in English. Not only does the course require the understanding of the presented concepts in a foreign language, but also it necessitates the skill of establishing a comprehensive structure of ideas and relationships. The students are therefore presented with tasks that they have never been prepared for throughout the years of education they received.

Our current study will therefore seek to find out whether the students' application of Mind Maps as opposed to their conventional note taking technique would improve their achievement

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and satisfaction in the course, and subsequently in courses of a similar nature. According to the study of Aykac (2014), utilization of Mind Maps enables the brain to use both hemispheres, which will facilitate learning and ensures the retention of knowledge. The purpose of this technique is to facilitate understanding using the skills of analysis and memorization in a diagram (Davies 2011). Mind Mapping differs from note taking techniques in that it does not have definite borders and shows how to support natural thinking processes (Meier 2007). In doing so, we will start with a review of a number of studies that are related to the topic under the study. Following that, we will present our readers to the study's structure, in which we include methods of data collection alongside an overview of the participants and procedure. The study's results will be then viewed and discussed in the light of the presented literature, in order to lay out a number of conclusions that fulfils the aim of the study.

LITERATURE REVIEW

The differences between Mind Maps and Concept Maps

The concept of Mind Maps was first introduced by Tony Buzan, the author of over 100 books and leading expert on the brain and thinking, who has developed a software package that enables its users to construct their own mind maps of what they want to read, learn or present (Buzan, 2005). It is important at this point to explain the differences between a mind map and a concept map. Concept mapping is a fairly conventional technique used by teachers to introduce a new topic. The technique usually presents a general topic at the top of the page, followed by the more specific details and explanations arrayed hierarchically below. Connecter lines in between would also contain keywords or phrases to summarize the relationships between the ideas. The ideas may also be cross-linked with each other to express the complex links among the topics. In a mind map, however, the constructor should start with the topic at the centre of the page, a main branch for each of the main ideas linked to the topic of study (sub-branches) for secondary ideas, followed by further lines (sub-topics) and so on. The lines should take the reader from abstract to concrete and from general to specific. Different colours should be utilized to add clarity and better visualization of the ordered ideas. Other features might also make the distinction between the most general into the most specific concepts, including the line thickness and style. According to Davies (2010), the two types of maps are similar in that both help the learner to achieve deep and not surface level of learning, as they both assist the students to understand, remember and analyse the various components of the presented material. However, in mind maps, any idea can be freely connected to any other with the aim being creative associations. Another use of mind maps is for memory retention, under the belief that remembering a diagram would always be easier than remembering descriptive presentations. Concept maps, on the other hand, outlines relationships between ideas. That's why they present a hierarchal structure of the presented material, with super-ordinate and subordinate components. In doing so, concept mapping enables meaningful learning, as it assists the learner to figure out the relationships between the new concept and the previous existing knowledge. Nevertheless, the construction of concept maps might be de-motivating in some cases, when the learners are overwhelmed with its rigid rules of construction (Eppler, 2006). In this vein, Davies has also mentioned argumentative maps as a third type of mapping technique that should follow an extremely precise language of construction, whereby the users display 'inferential connections and contentions…to evaluate them in terms of validity of argument structure and the soundness of argument premises' (Davies, 2010). As a result of its

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looser construction rules, mind maps are considered to be the most utilized type of maps as they can combine between the advantages of the other two more rigid maps, Davies adds.

Due to the nature of the course material, whereby one concept is associated to another, and super-ordinated for a few others, we chose mind mapping as it is claimed to represent concept associations, enhance information retention, and may easily be tailored according to our course requirements.

Mind Mapping and memory

Memorization has always been linked to a better learning process whereby the learner requires a mere recall of the piece of information required in that process. In this vein Tulving (1983; 1985) distinguishes between semantic memory and episodic memory as two separate but interactive systems of memory.

According to Tulving's theory of long term memory, knowledge is automatically filtered into the relevant memory systems over time in a step-wise process, starting with the episodic memory system, and then gradually losing context and shifting into the semantic memory system. By losing context, Tulving refers to the environment which the learner was present in whilst learning the item of information (Akbar et al., 2013).

Although remembering involves recollection of numerous extra details (involving larger quantities of information per fact recalled), a number of researchers have established that 'knowing' a piece of information may safely be considered a higher form of memory than 'remembering' (Conway et al. 1997; Herbert & Burt, 2001). Akbar et al. (2013) concluded, that on the basis of such findings, one may safely consider 'know' to reflect a more efficient learning than 'remember'. Glass and Holyoak (1986) relates the idea to the fact that mind mapping uses a technique of chunking, which helps us to use our short-term memory storage effectively. Those chunks of information would eventually transfer into our long-term memory. Batdi (2015) reports the results of his Meta-analysis concerning information retention to be not satisfactorily significant. In other words, for Batdi, the effect size of deploying Mind Mapping as a study technique tends to be too small to affect the learners' memory, hence, achievement.

Mind Mapping in education

Previous studies on mind maps indicate that mind mapping enhances the learning process from different aspects including brainstorming, note taking, consolidating information from sources, thinking through complex problems, presenting the overall structure of the subject, studying, retaining and recalling information (Adodo, 2013). The importance of mind mapping relies on the principle of learning as an active process, which conceives learning as ' what the learner does and not what the teacher would do to the learner' (Madu & Metu, 2012: 248).

Note taking has been described as being the main link between the students' knowledge and the topic of their studies. As a result, research on note taking has investigated the effect of various techniques of note taking on the students' level of performance in their academic tests. Simbo (1998) for example reported a higher level of achievement in the exams by the students whose note taking was based on their own style rather than their teacher's chalkboard notes. Bretzing & Kuhary (1994) conducted a study on the effect of two different techniques of note taking: encoding and verbatim. Their study showed higher comprehension scores obtained by the students who encoded their notes. Critical thinking was also linked to mind mapping. The relationship between mind mapping and critical thinking was examined within the discipline

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of medical education, since medical students are required to learn, retain and master a substantial amount of information in order to succeed in a medical school (Antoni et al. 2010). Although the authors of the study reported no significant differences between the standard note taking (SNT) medical students group and the mind mapping (MM) medical students pretest and posttest scores, they claimed that the results might have been influenced by the use of an unfamiliar technique of note taking, whereby the MM students had to focus on the learning of the new technique, yet were able to retain as much information as the SNT group whose full concentration was directed towards the new information learning. In his Meta-analysis study of Mind Maps, Batdi (2015) analysed the results of five masters and PH.D. theses in relation to the users' attitudes, for which he reported a medium effect size in favor of Mind Maps as opposed to conventional note taking.

Mind Mapping and second language learners

In countries where the educational system requires the students to be exposed to teachers' instructions in another language, note taking tends to be even of a greater effect. In Nigeria for example, Floyd (1984) states that notes produced by such students were mostly unorganized, non-economical and incomprehensible. Such notes have resulted in peculiar answers to the assessment questions. Madu & Metu (2012) have therefore examined the possibility of using mind maps as a solution for the issue of ineffective note taking, a problem hypothesized to be a product of a weakness in the students that is linguistic in nature, not cognitive. Their study revealed an improvement in the students' thinking skills amongst those who used mind mapping as opposed to the conventional note taking technique. The finding was due to, as the researchers of the study claimed, the open structure of mind maps, which seems to support the natural thinking process that takes place in the brain. Hence, in this study, we are trying to assess the effect of mind mapping as a note taking technique upon the students' ability to learn and retain the information presented in a language other than their native language.

In this study, we aim to determine whether the students' note taking technique would enhance the learning process. We will therefore investigate whether reading from one's own way of note taking in a mind map format will lead to a higher level of achievement in tests when compared to a regular type of note taking. We also aim to find out the effect of mind mapping on the students' memory. Another aim of the study is to explore the learners' level of satisfaction after using Mind Maps (MM) as opposed to standard note taking (SNT). In doing so, students will be asked to respond subjectively on whether they answered each MCQ test question based on 'knowing' the answer, 'remembering' the answer or 'guessing' the answer. As we explained earlier, the students' responses of 'knowing' should indicate a more solid level of memorization, while 'remembering' indicates a less level of certainty. 'Guessing' on the other hand indicates a complete absence of a related piece of information. By the end of the semester, the students will be requested to present a written account of their reflection on the two note taking techniques.

Our current study will therefore seek to answer the following questions:

1. How does using a self-constructed mind map affect the students' learning achievement of concepts presented in the learners' foreign language?
2. How does reading from a mind map affect the learners' long term memory?
3. What are the students' attitudes towards using Mind Mapping as a learning tool?

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RESEARCH METHOD

Participants

Our study's sample comprised 50 third/fourth year students who were doing their Psycholinguistic course as part of one of the selective courses on the English Department's major sheet during the fall and spring semesters of the academic year 2015-2016. The course presents the students to three main topics: 1st language acquisition, 2nd language learning, bilingualism and its effect on mother tongue and intelligence. A common feature of the course is that it covers topics that are highly technical and requires memorization of extremely technical terminologies in the discipline. As an instructor of the course for four consecutive years, I've noticed that one of the major difficulties faced by students is their exposure to highly technical terms and researcher names. The course is similar in its nature to topics presented in the medical field that requires advanced memorization skills. The fact that the learners are introduced to such technical terms and names in a language other than their own mother tongue makes the task even more complicated.

At the beginning of the semester, the students were introduced to the concept of mind mapping as presented by Tony Bozan's software. The students were trained on the software for three sessions. They were then asked to construct their own mind maps for chapter 1 on 1st language acquisition. They were also given a feedback session in which we evaluated the students' constructed mind maps. In case the students were still facing problems, we extended the mind map practice sessions to cover chapter 2 on 2nd language learning.

The third chapter 'Bilingualism' was mainly used to assess the effect of mind mapping on the students' achievement levels in the test questions. We therefore divided the class randomly to two groups, with 13 and 14 students per each group during the fall semester, and 12 and 13 students per each group during the spring semester. The students were asked to read the first half of the chapter in class for 45 minutes. Each group was then assigned a type of note taking to use for the read material in a session of 40 minutes. In the next class they were asked to bring in their notes and read them for 20 minutes before they perform a test that includes 10 MSCs, each followed by a subjective response question on whether they knew the answer, remembered it or guessed it. Each response was explained to the students before they start answering the items on the test paper in the manner that 'know' holds a higher level of certainty, 'remember' holds a less level of certainty, and 'guess' to indicate a random guess. A similar procedure was applied to the second half of the chapter, with the groups alternating to the other method of note taking.

Data collection

The data of the study were collected through two tests per participant, one after standard note taking (SNT), and the other after mind mapping (MM). In each test, the students were required to answer a set of 10 multiple choice questions (MCQs) that test their ability to recall concepts they read. The tests were quantitatively analysed to find out the number of correct vs. incorrect answers per test across each type of note taking technique (SNT & MM). The students' subjective responses on the certainty about their answers were also analysed to reflect on the effect of each note taking technique on their perceptions of the two study techniques. Students' correct answers in each test were also calculated to find out the effect of Mind Maps on the learners' memorization processes. The students' subjective answers were also evaluated

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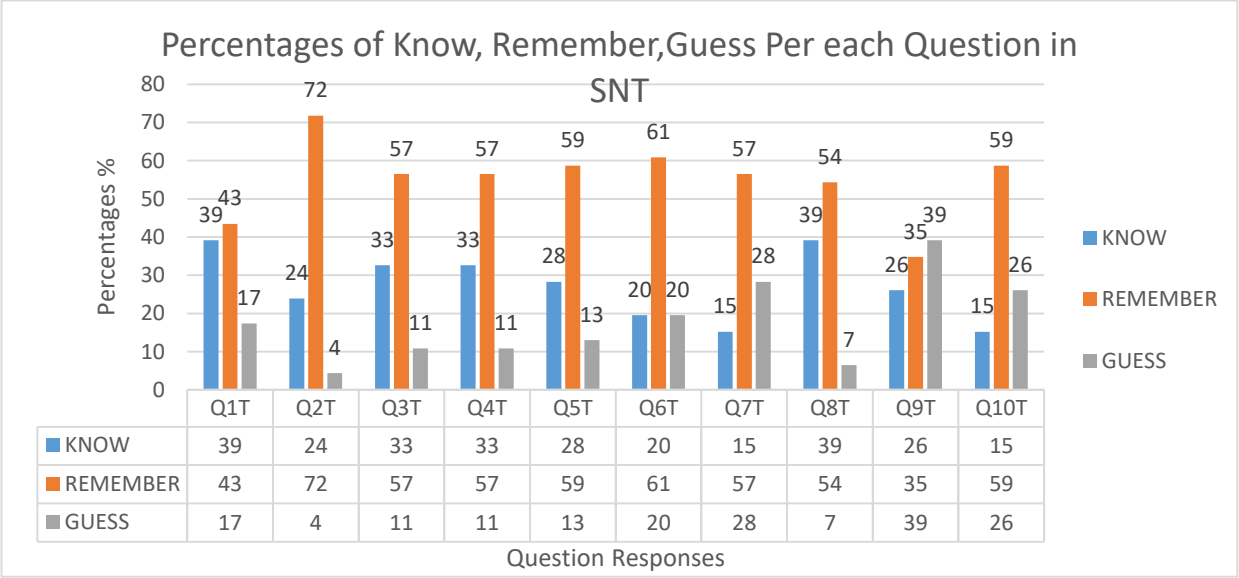
against the actual correct vs. incorrect answers, in order to reach out a satisfactory level of actual reliability.

The students' attitudes towards both learning techniques were additionally reinforced through individual flashcards that were presented to each participant in which they were prompted to write how they felt when they used each learning technique. Participants' responses were tabulated and analysed qualitatively in order to gain a more insightful profile of the learners' attitudes towards the techniques.

Study results

Quantitative Question/Answer sheets' results

The analysis of the data reflects twofold results: students' perception and the statistical results in correlation with the students' perception. From obtaining the frequency of the three responses (Know, Remember and Guess) for each question in both the SNT and MM study techniques, it appears that the majority of students, in all ten questions claimed they "Remembered" the answers, followed by the next majority claiming that they "Knew" the answers in all, but the last three questions, for which they claimed that their answers were a complete "guess" rather than a solid knowledge of the required information. Yet, the majority felt that they 'knew' the answer after trying MM (in all the questions), followed by "Remembering", and then "Guessing" the required answers. Chart 1 below shows the percentages for "Know", "Remember" and "Guess" per each question when the students utilised SNT.



	Q1T	Q2T	Q3T	Q4T	Q5T	Q6T	Q7T	Q8T	Q9T	Q10T
KNOW	39	24	33	33	28	20	15	39	26	15
REMEMBER	43	72	57	57	59	61	57	54	35	59
GUESS	17	4	11	11	13	20	28	7	39	26

Chart 1: Responses of Know, Remember and Guess for each question in SNT

In Chart 2, responses of the students per each question after utilising Mind Maps as a study technique show that the respondents mainly believed they "Knew" the required answers, followed by a second majority of those claiming they "Remembered" the answers, while only a minority of them stating their answers to the questions were a complete "Guess".

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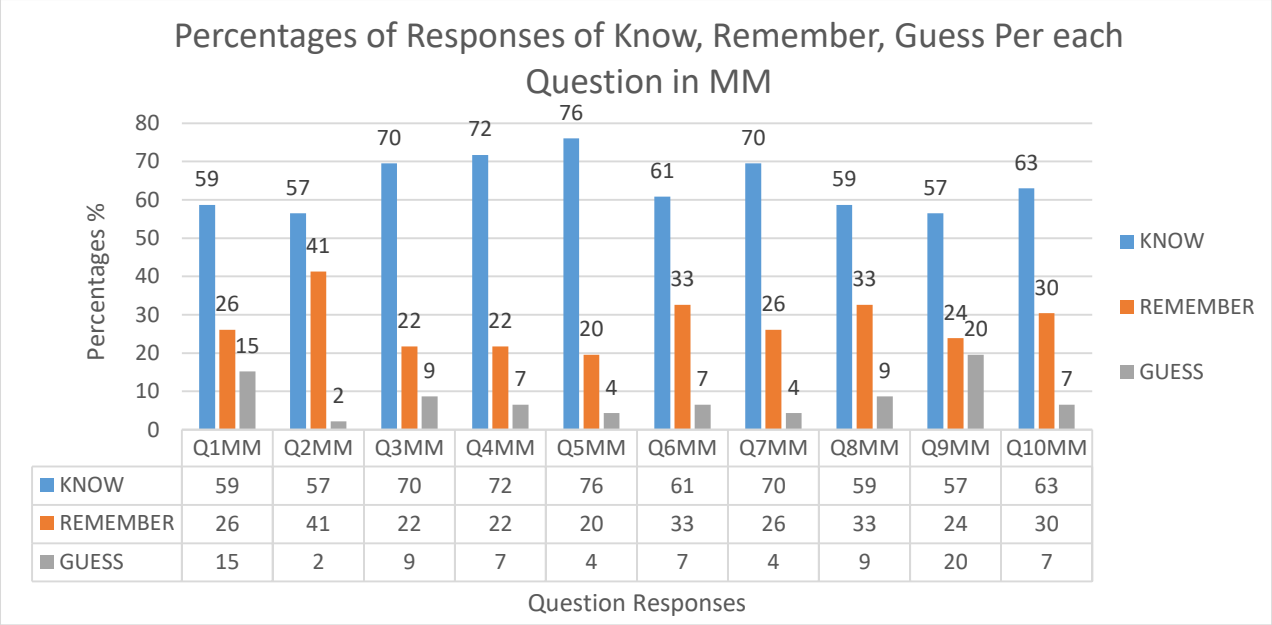

Chart 2: Responses of Know, Remember and Guess for each question in MM

The second part of the analysis examined the statistics to determine the percentages of correct answers after using SNT and MM when correlated to their perception of correctness of their answers First, in order to start the comparison it was essential to look at the percentages of total correct answers in SNT vs. MM. With our statistics showing 323/920 correct answers (comprising 35% of the total number of answers) when the students used SNT, and 375/920 correct answers (41%) when the same students utilised MM, we can clearly state that students were at an advantage when they used MM as opposed to SNT (See Chart 3 for details). This proves that the use of MM helped the students recall information more than it did in SNT.

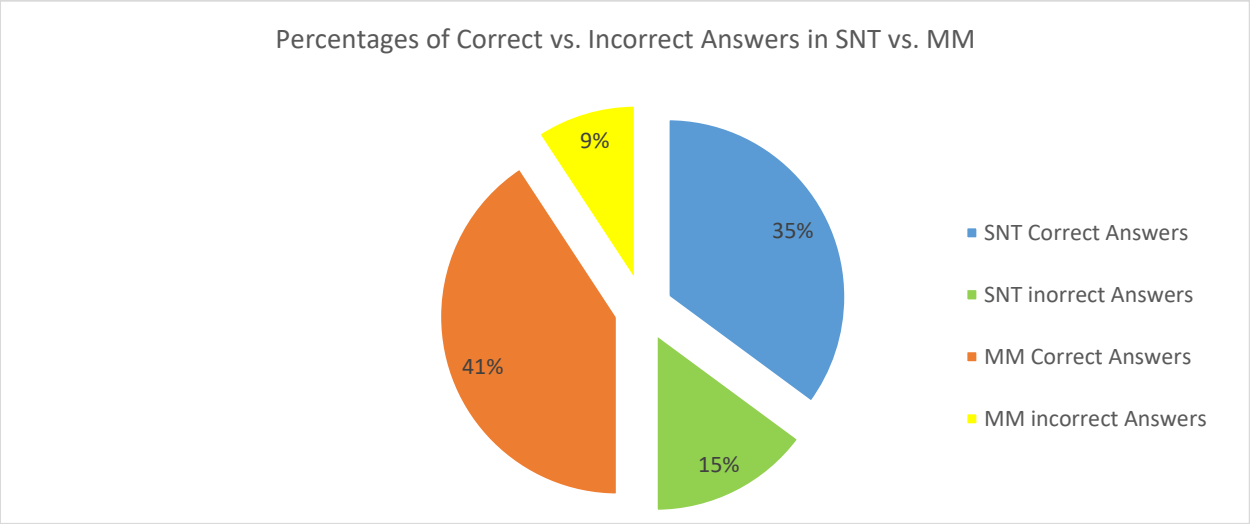

Chart 3: Correct vs. Incorrect answers in SNT & MM

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Our next goal was to correlate this finding to the respondents' beliefs of how well they did in the tests. We therefore investigated the overall responses of "Know", "Remember" and "Guess" in SNT vs. MM (See Chart 4 for results). Once again, the results present a very high majority of "Know" responses in MM, and a high majority of "Remember" responses when they used SNT. The overall results also show that more students in SNT believed they "Guessed" their answers when compared to MM (18% & 8% respectively).

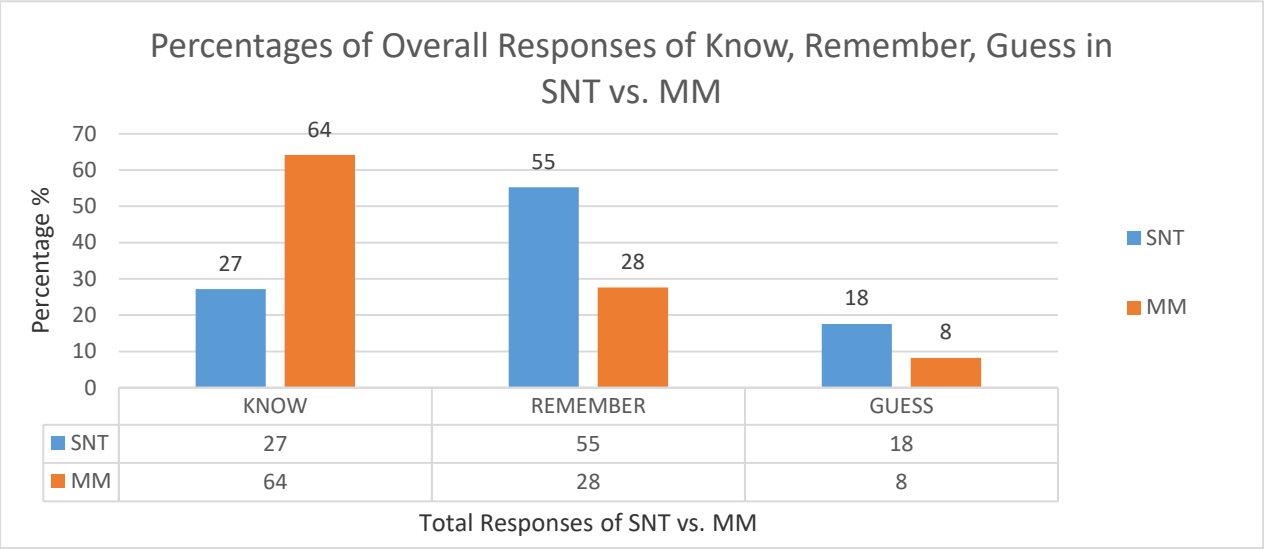

Chart 4: The overall responses of "Know, "Remember" and "Guess" in SNT vs. MM

Qualitative Flash cards' responses

Investigation of the students' responses on how they felt about using the two study techniques namely Standard Note Taking (SNT) and Mind Mapping (MM) shows the following trends:

a. 23/50 students expressed their initial confusion and ambivalent attitudes when they started deploying the Mind Mapping as a learning technique, and even after completing the preparation sessions at the beginning of the semesters. Below is an example of the way one of the students expressed her confusion:

> *"MM was initially confusing. I didn't know how to classify the information I read from the chapter into a diagram. I was reluctant on when to use different colours, different shapes of boxes, and even different arrows. My second MM was much better. So it was easier for me to recall the information and answer the test questions"*

Another student wrote the following:

> *"I like SNT more because I'm used to it. I spent all my education years doing it. So it feels more appropriate to me. I admit, MM made the picture clearer, but it really takes so much effort and time to construct one. I'd rather use my time in studying than constructing a mind map."*

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A similar point of view was indicated in what another participant reflected on her flashcard as below:

> *"I've never done this before. I mean MM. So I feel I'm not confident yet. I think we needed more time to practice using mind maps in our education. I'm surprised though how such a technique has never been presented to us in schools!"*

b. 12/50 students expressed their full satisfaction with MM as a learning technique. Below are two of the students' reflections as elicited from their flashcards:

> *"I loved MM. It's so easy to construct and makes everything extremely clear. I wish I knew about it when I was in school. Things could've been made so much easier for me."*

> *"At the beginning I thought that it's easier to use NT in studying the chapter. But when I actually started answering the questions I found out that I was able to remember every piece of information I placed in my mind map. I will definitely use MM technique in my future courses."*

c. 9/50 students stated neutral attitudes towards using both SNT and MM. The following reflections represent their views:

> *"I think that both SNT and MM assisted me in remembering the required information. Sometimes, MM might be more appropriate to certain types of concepts than others."*

> *"Using SNT or MM forced me to read the chapter over and over again. So I think how much I remembered had nothing to do with the learning technique. If you study enough, you'll definitely remember better."*

d. 3/50 students viewed MM negatively as below:

> *"I don't think MM is a good idea. It takes so much time and doesn't help in recalling the information. So why do I put so much effort in something useless!"*

> *"MM is a useless studying technique. I will never recommend it to anyone."*

> *"It's a waste of time. I mean Mind Mapping. Many of the concepts I read in the chapter do not fit into a mind map!"*

Study discussion and Findings

This section presents the findings of the current study in relation to our three research questions:

What are the students' attitudes towards using Mind Mapping as a study technique?

Investigation of the students' subjective responses per each question in both sessions (SNT & MM) shows that the students have mainly believed they "Knew" the answers in every single question when they used their self-constructed mind maps as a study technique. On the contrary, results of the same respondents show that they mainly believed they "Remembered" the required information when they used Standard Note taking technique. The findings suggest the following:

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a. Students tend to feel more confident about their answers when they use Mind Maps as a study technique than when they use standard notes.

b. In a number of questions (namely 8, 9 & 10), the students believed their answers were a complete guess when they used standard notes. This in fact suggests even less confidence levels when the students used SNT as opposed to MM.

A thorough examination of the students' collective responses across the three subjective options (Know, Remember, & Guess) shows a much higher majority of "Know" responses when the students used Mind Maps in comparison to Standard Note Taking (64% vs. 27%).

In Standard Note Taking technique, results on the other hand indicate a majority of "Remember" responses in comparison to their responses after using Mind Maps (55% vs. 28% respectively). The collective results also show more "Guess" responses in Standard Note as opposed to Mind Maps (18% vs. 8% respectively). The findings in fact signal very high levels of confidence in Mind Maps as a study technique. Such high differences in the percentages claimed towards the three responses of 'know', 'remember', and 'guess' tend to meet what Batdi (2015) reports of medium-high effect size in favor of Mind Maps as opposed to regular note taking techniques.

How does using a self-constructed Mind Map affect the students' learning achievement of concepts presented in the learners' foreign language?

One of our main objectives in the current study is to know whether such high levels of confidence was actually reflected in the students' responses. We therefore looked closely into the frequency of correct answers per each utilized study technique. Investigation of the results showing 35% correct answers in SNT as opposed to 41% correct answers in MM suggest that, not only did the students think they had done well when they used Mind Maps as a study technique, but also they outperformed themselves when they used MM as opposed to SNT. Our findings in this regard indicates that the students' high expectations of their answers were actually reflected into their performance. Hence, we can safely state that students tend to perform at a higher level when they utilize Mind Maps as a study technique than when they use Standard Notes. Our results in this regard seem to have contradicted Antoni and his associates' findings on the effect of Mind Mapping on the students' performance at a medical school (Antoni et al, 2010). The findings might also have supported Antoni's explanation, whereby they suggested that the results could've been influenced by the fact that the sample had used an unfamiliar technique of note taking. In fact, a number of responses in the current study's participants' accounts direct us towards a similar explanation.

How does reading from a self-constructed Mind Map affect the learners' long term memory?

Our next step was to look into the effects of Mind Maps on memory. Referring to the current study's literature review on the concept of memory, Tulving (1983) claimed that during the memorization process, two systems get into work; semantic and episodic memory. Tulving elaborates, during the process, the human's brain starts with episodic memory system, and gradually loses context and shifts into the semantic memory system. He therefore views semantic memory to be a more solid memory system, whereby the learner loses any information of the setting at which the information was presented to the favor of restoring more space for the information to get into a more solid part of the brain. Tulving and a number of

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other researchers in the field believe that the loss of such details would save some space for more information to get restored. To distinguish between the two systems, researchers in the field established a distinction between "Know" to refer to semantic memory and "Remember" to refer to episodic memory. Thus, in our current study we used a similar concept, with the objective of looking into the effect of Mind Maps on the learner's memory. In the light of Tulving's memory theory, our results show a higher percentages of "Know" responses after using Mind Maps, which could signal a faster transition from the short term memory system (indicated in the number of "Remember" responses, into the long term memory (indicated in their "Know" responses). Our findings tend to be in line with Glass and Holyoak (1986), who related the higher level of 'knowing' than 'remembering' when learners use Mind Maps, to the idea of 'chunking', that assists the learner to keep more information in his/her short memory storage until it successfully can be transferred into the learner's long term memory.

On the other hand, the higher percentages of "Remember" responses after using Standard Notes, and the occasional high scores of "Guess" responses may reflect a slower transition of the studied information into the performers' memory. With that being reported, we believe that our findings question Batdi's (2015) Meta-analysis reports of the small effect size of Mind Mapping on memory, hence, achievement.

Analysis of the qualitative data on the other leads to the following findings

Our study's qualitative data represented in the students' views as reflected on the flashcards at the end of the semester show the following:

a. Despite the findings signaling higher performance of the students after using Mind Maps, direct responses on the flashcards provided to the students indicate ambivalent attitudes towards the application of Mind Maps as a future study technique amongst 46% of the study's sample. It seems that the views were mainly the result of using the technique for their first time during their academic life (See respondents' views in the qualitative results section).

b. Around 24% of the sample expressed their full satisfaction in Mind Maps as a learning technique.

c. A group of the qualitative responses (comprising around 18% of the sample) indicates neutral views on using Mind Maps.

d. Approximately 6% of the study's sample expressed an extremely negative view of Mind Mapping as a study technique.

CONCLUSION

This study is an attempt to identify the effect of mind-mapping technique on the students' academic achievement, attitudes and retention scores. The all-female students, studying psycholinguistic, were trained to analyze the chapters they were studying using Mind Maps. Achievement scores were collected prior and post use of Mind Maps. Moreover, the students were asked to reflect on their experience, providing pros and cons of the use of Mind Maps.

Our findings suggest an elevated confidence levels associated with Mind Maps as opposed to regular note taking techniques. Most students stated they 'knew' the answers after using Mind

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Maps, while they "remembered' the information when using regular note taking. When students were asked to reflect on their experience on flash cards, majority of the participants favored the use of Mind Maps. This has been said while analysis of the qualitative data suggest an ambivalent attitude profile, which is more likely due to the fact that all respondents were using Mind Maps for the first time throughout their academic life.

As for the students' achievement scores, a prominent effect size has also been deduced in favor of Mind Map technique. Clearly, the use of Mind Maps supported the students' memorization and showed significant impact on their ability to 'know' rather than 'guess'. Although some students noted that Mind Maps take a long time to construct, it is clear from their scores that the time was efficiently used to retain information for longer.

With regards to information retention, once again, our study tends to signal much higher levels of information retention when the students used Mind Maps. With the use of regular note taking, on the other hand, the students tended to forget details and reverted to guessing.

Conclusively, the findings of our study tend to suggest that Mind Maps, when efficiently used as a study technique could enhance the immediate students' knowledge retention, build their confidence in learning, and reinforce their memory. Implications of the study's findings suggest that teachers should start implementing the use of mind maps early in the school years. Curriculum designers should also consider assigning part of the curriculum to presenting the skill of Mind Maps. This will, in fact, enable the students to familiarize themselves with Mind Mapping as a strong study technique to be adequately implemented in their future education, especially in fields where they would be required to learn huge chunks of information within extremely short time frames.

Limitations of the Study

Ideally, the conclusions reached in this paper would have been more solid if the procedure has sustained in multiple tests across different time frames for each study technique. Hence, we recommend further studies in this regard to be able to confirm the results after the students have used MM for a good amount of time. We also recommend the conduction of a similar study that deploys mixed gender participants. This, we believe, will enable us to find out whether the use of mind mapping could elicit different conclusions when involving the gender factor.

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