Measuring Student's Memory Recall of Syntactical and Numerical Concepts: A One-time Experimental Research

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ABSTRACT

This study investigated the student's recall process of syntactical and numerical concepts. Participants of the study were college students (N= 40) from different programs. The study utilized a between-group design composed of two different treatment groups. A non-parametric statistical tool, Mann-Whitney U test, was used to assess if there is a significant difference between the two groups. Students were engaged in a 15-minute session, tasked to memorize 15 random syntactical and numerical codes. After the 15- minute session, they were tasked to write down the memorized codes on the paper provided. Results from Shapiro-Wilk normality test (W=0.934) revealed a violation of normality with the data. In addition, findings from independent t-test (p=0.025) suggested that students have better memory retention with syntactical rather than numerical codes. Furthermore, findings of the study suggest focusing with improvement in terms of student's memory retention of numerical concepts. Suggested adjustment of the allotted time for session should be concerned and programs for memory retention of students be prioritized.

Keywords: Recall Process, Memory Recall, Memory, Syntactical, Numerical, Experimental Research, True Experiment

INTRODUCTION

Whether letters (syntactical concepts) or numbers (numerical concepts) are easier to remember has been the subject of numerous studies in cognitive psychology. Understanding memory recall is essential for academic success, underpinning how students process and retrieve learned material (Radvansky, 2022). Memory, as defined by Radvansky (2017), is a cognitive process responsible for acquiring, storing, and recalling information. Memory recall is significant in educational contexts, where students must retrieve information efficiently. Memory recall is the process by which information is retrieved from long-term memory, and its efficiency plays a critical role in students' ability to perform academically.

This study investigates the difference between students' recall processes of syntactical and numerical concepts. Research on memory recall has traditionally focused on the retention of letters and numbers, though findings on which is easier to recall remain mixed. Recent studies indicate that letters might be easier to recall than numbers. For example, a study by Smith et al. (2022) showed that participants recalled syntactical information (letters) more effectively than numerical codes. This finding supports the notion that more structured and meaningful letters are processed more efficiently in memory. Conversely, a study done by Sadowski et al. (2013) suggests that numbers might be easier to recall due to frequent usage in everyday tasks like phone numbers, dates, and mathematical operations. In addition, it is found that participants performed better in recalling numerical sequences, emphasizing the importance of numbers in cognitive tasks such as arithmetic. Additionally, Johnson (2022) reported that students showed a stronger recall of syntactical sequences after brief exposure, suggesting familiarity and context play a role in memory recall. This contrasting evidence highlights the complexity of memory processes and how different types of information may be recalled differently depending on context and familiarity.

A study conducted by Shubham Gargrish et.al (2022) that lasted for two months illustrated that Augmented-Reality based learning provided a better memory retention compared to Interactive Simulation based learning.

Meanwhile, Comighud (2021) examined factors that influence a student's memory. The participants were Grade 7 students from Bayawan City, Philippines. "The salient findings revealed that the extent of students' perception on factors contributory to memory retention were "high" in terms of motivational practices and experiences, goal setting and accomplishments, and personalized learning, while they perceived the use of teaching strategies and learning activities and the utilization of educational resources and learning devices to be "very high"."

To further fuel the comparison between letters and numbers, 7±2 theory, formerly known as Miller's Law (1956), explains that we can hold seven "seven" items in short-term memory, plus or minus two. He believed that our short-term memory stores "chunks" of information rather than individual numbers or letters. Miller's Law is supported by psychological research, in accordance with Jacobs' (1887) experiment using a digit span test, to examine the capacity of short-term memory for numbers and letters. From a 443 sample of female students, Jacobs found that the participants had an average of 7.3 letters and 9.3 words, which supports Miller's notion of 7±2. The results also revealed a superior average from letters and words compared to numbers, which suggests that it takes around 5-10 minutes to memorize numbers.

Previous studies conducted regarding the assessment of the recall process of syntactical and numerical concepts were limited to sentence fragments, 2-letter combinations, mathematical formulas, numerical passwords, and etc. There are no exact studies found to be assessing the retention of syntactical and numerical concepts. In order to fill in this gap, this study intends to examine student's memory retention of syntactical and numerical concepts. Purposely giving light to various enigmas surrounding this phenomenon. This research aims to investigate the difference between the recall process of syntactical and numerical concepts among students. The findings of this study may greatly contribute to existing bodies of knowledge and be a fundamental basis for future programs to be implemented. Accordingly, cognitive load theory (Sweller et al., 2011; Sweller et al., 2019) explains that humans process information in two ways: primary, unconsciously; and secondary, consciously. Secondary information, acquired through problem-solving or from others, is temporarily held in working memory before long-term storage. Long-term memory, unlike working memory, has seemingly unlimited capacity. Instruction builds long-term memory, creating expertise differences between learners. These differences necessitate tailored instruction, highlighting the "expertise reversal effect" in cognitive load theory.

Baddeley and Hitch's (2019) model of working memory includes the phonological loop and visuospatial sketchpad, both working under the direction of the central executive. The phonological loop handles auditory information. It has two parts: the phonological store, which briefly holds sounds, and the articulatory rehearsal process, which extends the storage time through repetition. The visuospatial sketchpad processes visual and spatial information, allowing mental imagery and navigation. Essentially, the model suggests separate systems for handling different types of information within working memory, all coordinated by the central executive. Accordingly, memory retention of individuals differs depending on the information they are required to memorize and retrieve. According to Atkinson & Shiffrin's multi-store model (1977), information in short-term memory only lasts around 30 seconds. Cognitive abilities affect how individuals process information in working memory. Additionally, attention and focus on the most important information also play an important role in encoding it into long-term memory. Furthermore, repetition significantly helps the ability to remember details for a long time.

Despite these differing findings, limited research directly compares memory recall of syntactical and numerical concepts.

Given these disparities in findings, this study aims to look into the differences in recall processes for syntactical (letters) and numerical (numbers) concepts. Specifically, the research will examine how students recall these two forms of information and the factors that may influence their recall processes. In this study, the researchers provided 15 codes for the syntactical and numerical groups, each with a 5-figure combination. The study seeks to answer the following research questions:

1. Is there a significant difference between students' recall process of syntactical and numerical concepts?
2. How does students' recall process of syntactical and numerical concepts differ from each other?

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METHODS

Participants

The participants of the study were college students (N=40) coming from different programs, representative samples from the whole population of college students currently enrolled in University of Mindanao - Digos College. Participants were randomly selected and assigned to either Syntactical or Numerical groups. Syntactical group was composed of 20 students (females, males); Numerical group also had 20 students involved (females, males). The majority of the participants were Information Technology students and some were Psychology students.

Having at least 15-20 participants in each group condition in quantitative research is generally considered ideal for several reasons: statistical power, representatives, reducing the impact of outliers, allowing for subgroup analysis, and meeting minimum requirements. However, it's important to note that the ideal sample size depends on several factors, including: the complexity of research design, the expected effect size, and the variability of the population. According to the article of Sauro and Lewis (2016), having at least 40 participants in your study can guarantee a 95% confidence level, 15% desired margin of error, and could be interpreted as "low risk, good precision".

Procedure & Design

The study utilized a between-subject group design, and garnered results were interpreted via an independent t-test. Syntactical and Numerical groups were both the experimental group being primarily exposed with the research procedure; division of participants were decided through random assignment The participants are well-informed and briefed before practically joining the experiment. Researchers provided consent forms to be voluntarily signed by the participants as part of orientation process and ethical standards.

Instructions were given at the beginning of the orientation before properly operating the experiment. Students were informed of the purpose, direction, and goal of the research, each were given autonomy in giving consent to the conduct of research. Procedures done for both the Syntactical Group and Numerical Group were identical and no variations of instructions were performed. Students under Syntactical Group were tasked to memorize letter combinations (syntactical codes), Numerical Group were tasked to memorize number combinations (numerical codes). All participants were exposed to a 15-minute session where they are tasked to memorize as many codes as they can from the given 15 random letter and number combinations. At the end of the session, they were given answer sheets to be utilized in writing their answers. Students were given 5 minutes to recall the codes that they've memorized. Answer sheets are then collected by the facilitators and kept safe for the checking process. Information regarding the participants and their data provided are kept anonymous, hidden from other's eye and knowledge.

The research design used in this study is between-subject design. This methodology is appropriate for the study since its goal is to measure the recall process of students of syntactical and numerical concepts. According to Edmonds and Kennedey (n.d), "the between-subjects approach, also known as a *multiple-group approach*, allows a researcher to compare the effects of two or more groups on single or multiple dependent variables (outcome variables)".

Instrument

The syntactical and numerical codes were prepared by the facilitators ahead of time-letter and number combination were completely random entities. The syntactical and numerical codes were composed of 5-letter combination (syntactical) and 5-number combination (numerical).

Table 1. Syntactical codes used in the experiment

HGTRF	PLWSA	KHFRT
BTRYN	LKJOI	MLQSD

MLHYT	DFGRS	VGTRF
FRWDS	VCXGT	NHIKL
BWSDA	ZWQDR	CRTYX

Table 2. Numerical codes used in the experiment

36754	49826	19876
92061	45391	25417
74983	34287	80304
62954	42193	53290
32081	76540	69833

For the data analysis, an independent t-test was utilized. Mann-Whitney U test, a non-parametric test was used to determine differences between the scores of two groups. It is most suitable to be utilized considering the fact that the data was skewed, not normally distributed.

Raw scores of the experimental groups were analyzed and later on interpreted. The normality of data was also tested through the Shapiro-Wilk test. Cohen's d to check the effect size of the variables was also used.

Ethical Considerations

Students participating in this study will be provided with a consent form explaining the purpose of the study, its procedure, the risk, method that will be given, and the purpose of the study. The students are given the opportunity to participate in the experiment voluntarily and should sign the form before participation. Participants' personal information and data should be kept confidential, anonymous, and restricted from the unauthorized person to ensure privacy.

The experiment should not cause any harm or negative consequences to the participants. Researchers must ensure a safe environment during the experiment and must reduce the risk of accidents and should be careful. Participation is voluntary, and participants may withdraw from the experiment at any time without penalty. Experimenters should not force the students to participate in the experiment.

RESULTS

Results from the Independent t-test suggested that there is a significant difference between the results of student's recall process of syntactical and numerical concepts.

Table 3: Descriptive Database

	N	Mean	Median	SD	SE
Syntactical	20	9.25	9.50	3.32	0.743
Numerical	20	6.90	7.00	2.20	0.492

Table 3 shows the descriptive statistics on students recall process of syntactical and numerical concepts. As shown in the table, the mean quantity of syntactical codes memorized was M=9.25 (SD=3.32, SE=0.743), while the mean quantity of numerical codes memorized was M=6.90 (SD=2.20, SE=0.492). Each group included N=20.

Table 4. Normality Test

	W	p
Scores	0.934	0.021

Table 4 shows the normality of data, the Shapiro-Wilk test was used. For the quantity of codes memorized, the results indicated a significant deviation from normality, *W*=0.934, *p*=0.021. The results suggest that the assumption of normality was violated for this variable.

Table 5. Independent t-test

	N	Mean	Median	SD	SE
Syntactical	20	9.25	9.50	3.32	0.743
Numerical	20	6.90	7.00	2.20	0.492
Statistics		Value			
t		2.64			
df		38			
p		0.025			
Cohen’s d		0.834			

An independent-samples t-test was conducted to compare the overall scores of syntactical and numerical groups in terms of their memory recall. The results indicated a statistically significant difference in overall scores between the two different groups, *df* (38), *t*=2.64, *p*=.025, *d*=0.834. Participants belonged to the syntactical group and were tasked to memorized syntactical codes (*M*=9.25, *SD*=3.32), compared to those who are tasked to memorized numerical codes (*M*=6.90, *SD*=2.20). The effect size, as measured by Cohen's d, suggests a large effect of both the syntactical and numerical groups. A large Cohen’s d effect size indicates that the difference between two groups is practically significant and important. “If a result is statistically significant, that means it’s unlikely to be explained solely by chance or random factors”.

Since the p-value was less than .05, the null hypothesis, which stated that there is no significant difference between the scores of syntactical and numerical groups, was rejected. These findings suggest that syntactical codes are easier to memorize compared to that of numerical codes.

DISCUSSION

The study investigated student’s recall process of syntactical and numerical concepts- whether they can memorize more syntactical than numerical codes or vice versa. The experiment included 40 college students from various programs at the University of Mindanao-Digos College to assess their memory recall of syntactical and numerical concepts. Given the p-value was below .05, the null hypothesis-asserting no significant difference between the scores of the two groups-was rejected. Consequently, the results imply that the syntactical codes are generally much easier to memorize than numerical codes.

Crannell and Parrish (1957) conducted a study on the comparison of immediate memory span for digits, letters, and words. It demonstrated a slight superiority at all ages in letter-span over digit-span, and a clear inferiority of span for nonsense syllables. Moreover, there is a not so obvious comparative difficulty between reproduction of letters and numbers. The gap between syntactical and numerical reproduction wasn’t strongly evident, but superiority of syntactical scores was present in various areas. In a 1969 experiment, Ranschburg found that identical numbers in a list made the list harder to remember. He believed similar numbers blended together, confusing the memory. This result may also explain as to why it is harder to recall numerical codes than syntactical codes. With these studies, we can conclude that there is a difference between student's recall process of syntactical and numerical codes.

In addition, Baddeley (1964) concluded that the more redundant the letter sequence and the longer the exposure time, the more effectively the sequence can be coded and the better it will be recalled. This suggest that familiarity to the subjects brought by prolonged exposure greatly influenced the individual's memory recall. Meanwhile, according to the number sense perspective (Active Construction View) by Baroody (2009)," memorizing the basic number combinations entails constructing a knowledge that involves patterns, relations, algebraic rules, and automatic reasoning processes, as well as facts. In effect, fluency with the basic number combinations begins with and grows out of number sense." The result entails that memory recall of numbers is more difficult due to various reasons, for it outgrows the number sense and it is carrying the difficulty to even memorize basic number combinations. In addition, Westwood (2000) conducted the one Minute Basic Number Fact Tests that examines student's memory recall of basic number facts. The results identified that the students are struggling to recall basic number facts, some had instant recall, but the majority of students struggling with memory recall showed superiority between the two. Moreover, only few research studies investigate the comparison of an individual's recall process of syntactical and numerical concepts leading to a more complex development for this topic. Also, several studies about memory retention only focus on letters or numbers alone; there are no general results for comparative difficulty on memory recall for both concept.

Factors such as familiarity, compatibility, and focus, should also be studied to address issues that could impact individual's memory and recall processes. Parkin et al. (2001) investigates how familiarity with letter combinations influences word recognition. The effect of familiarity was stronger when the words contained letters that were more common or predictable in the language. This emphasizes the importance of the statistical structure of letters in word recognition. In addition, Hunt and McDaniel's theory (1993) suggests that our brains process information by comparing similarities and differences between stimuli. This framework helps to understand how familiarity with letter patterns influences word recognition. Individual's familiarity with letter structure and word recognition increases its advantage to better memorize syntactical than numerical concepts.

Moreover, memorizing numbers can be one of hardest things to do, normally because, you can't "visualize" numbers the way you can visualize letters and words. A study done by Rinck (1999) investigates people's memory retention on everyday objects, focusing on number related objects, revealed that despite frequent usage of these devices, free recall of the numerical layouts is quite poor; and that the layout on calculators is even harder to recall than the telephone layout. This proves that individual's struggle to retain information on numerical concepts.

The question regarding "what is easier to remember?" has been solved, based on the results of the data gathered, it is easier to memorize and recall syntactical codes compared to numerical codes. The conduct of the experiment may be time-limited but it provided valuable insights about the topic. Results of the study are drawn and evaluated but it is only limited to the student's memory retention results and does not further discuss the factors that could affect the performance of students. Replication of the experiment may also be applied to further establish the result. Between-subject designs was suitable and best for it's conduct. The finding of this experiment provides compelling evidence that students demonstrate significantly greater memory retention for syntactical concepts compared to numerical concepts with a mean of 9.25. Previous research proves that individual's struggle to retain information on numerical than syntactical concepts. Further experiments on this approach are considered necessary to explore and study more about the said topic since it is related to cognitive mechanisms.

Furthermore, the current experiment may be helpful to school and universities, researchers, and as well as the students who want to conduct the same study with this experiment. As it will play a significant role in providing information about what concepts (syntactical or numerical) students are most likely to memorize easily and mostly easier to remember. Tasks and other activities to stimulate individual's working could be done by future researchers to fully establish significant results and contribute to the society. Considerable factors should also be considered and adhered. A single 15-minute session isn't enough to fully explain the phenomenon. Real-world memory retention requires more than a single 15-minute session of memory recall.

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-The Researchers

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