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THE APPLICATION OF MNEMONIC KEYWORD APPROACH AND ITS IMPACT ON FORMATIVE ASSESSMENT - A CASE STUDY

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Abstract:

This case study investigates how individuals with a left-brain orientation comprehend and manage information overload using the Mnemonic Keyword Approach, focusing on students enrolled in the ENT300 course (Fundamentals of Entrepreneurship). The research aims to evaluate the impact of mnemonic techniques on academic performance in formative assessments. By analyzing student performance, the study seeks to determine the effectiveness of the Mnemonic Keyword Approach in enhancing understanding and information retention among left-brained individuals. The Mnemonic Keyword Method, which encodes information into easily retrievable and memorable formulas, was applied in teaching and learning activities. Using the Sommer-Sommer Brain Test, students were categorized by brain orientation to tailor the mnemonic techniques accordingly. Results indicated a significant improvement in knowledge retention, with assessment scores ranging from 75% to 97.75%. This improvement is attributed to the method's ability to provide meaningful coding and abbreviation formulas, enabling students to construct answers based on keywords. The study concludes that the Mnemonic Keyword Approach is a highly effective strategy for memorizing and retaining knowledge, as it facilitates the encoding and retrieval of information in a structured manner, thereby enhancing students' understanding and performance in formative assessments.

Keywords:

Mnemonic Keyword Approach, Formative Assessment, Brain Dominance, Left-Brain-Oriented & Brain-Based Learning

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Introduction

Several theories suggest that learners utilize different mental processes as they learn. A scaffolding framework and just-in-time information presentation effectively manage cognitive load and enhance complex learning, crucial for left-brain-oriented individuals (Merrienboer, Kirschner & Kester, 2003). Educators should tailor teaching methods to students' learning preferences and brain dominance. Ismail et al., (2022) found a significant relationship between knowledge retention and teaching tools via student feedback.

Several brain researchers, including Dunn and Dunn (1992), Kolb (1984), and McCarthy, McCarthy (2006) have explored how students' learning styles relate to the brain's hemispheres. Their findings indicate that people have different learning styles or preferences, suggesting that teaching methods should be multi-dimensional. McCarthy, McCarthy (2006) proposed integrating various techniques to engage right-brain and left-brain processing. This detonates students' capabilities completes the cycle of meaningful learning and develops a model with eight pedagogical perspectives that should be covered in their entirety to connect teaching with student learning effectively.

Howard Gardner's Theory of Multiple Intelligences (Gardner, 1983) suggests that learners utilize different mental processes as they learn. According to this theory, there isn't just one way to measure intelligence; instead, there are multiple types, each reflecting different capabilities. For example, some people may excel in logical-mathematical reasoning, while others might be more adept at interpersonal or linguistic skills. This framework implies that traditional educational models, which focus on a narrow set of skills, might not fully capture the diversity of students' strengths. Thus, teaching methods should be broadened to accommodate a range of intelligences, allowing all learners to thrive.

A framework for scaffolding practice and just-in-time information presentation can effectively control cognitive load and enhance complex learning in authentic tasks. Complex learning involves integrating knowledge, skills, and attitudes, which requires coordinating various constituent skills. The transfer of learned information in complex learning activities is typically limited by the human mind's processing capacity, especially among individuals with a predominantly left-brain orientation. This case study aims to evaluate the application of the Mnemonic Keyword Method in the teaching and learning process of the university-required course, ENT300 (Fundamentals of Entrepreneurship), at the Universiti Teknologi Mara (UiTM) Pulau Pinang branch. The study specifically focuses on assessing the method's effectiveness in enhancing knowledge retention among left-brain dominant Mechanical Engineering students. By integrating this technique into the teaching and learning activities, the research seeks to determine how well the Mnemonic Keyword Method supports left-brainers in retaining complex information and theoretical content. Additionally, this study examines the broader applicability of the approach for other academic subjects, with a particular focus on its potential for enhancing learning outcomes in disciplines that require intensive reading and comprehension of complex terminologies. Through this analysis, the research aims to contribute valuable insights into the role of brain dominance in education and the adaptability of mnemonic strategies in diverse learning contexts.

The Dunn and Dunn Learning Model (Dunn & Dunn, 1992) highlights individual learning preferences and their correlation with brain hemispheres. Left-brain learners are typically more analytical, logical, and sequential, favoring structured and step-by-step instructional methods.

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In contrast, right-brain learners are creative, have a holistic thinking ability, and have visual-spatial skills. They are categorized as global learners with big-picture thinking. The Dunn and Dunn model addresses various learning stimuli comprising of psychological, physiological, and sociological preferences, accommodating cognitive differences between these learner types. By incorporating hemispheric dominance into its framework, the Dunn and Dunn model promotes brain-compatible learning environments that improve educational outcomes by aligning the brain hemisphere specialization and individualized learning styles and optimizing instructional strategies, ensuring that teaching methods cater to diverse cognitive processes and ultimately enhancing the learning experience for both left-brain and right-brain learners.

The Kolb Learning Model connects with learners' brain dominance by emphasizing experiential learning and how individuals prefer to process and internalize information (Kolb, 1984). Kolb's model has four learning styles namely; Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. These learning styles can be aligned with different cognitive and brain hemisphere preferences. Left-brain learners are connected to Abstract Conceptualization and Active Experimentation as they focus on logic, reasoning, and analytical skills. These learners preferred structured learning environments to apply theories and test ideas systematically. In addition, Right-brain learners are typically associated with Concrete Experience and Reflective Observation, as they are more creative, intuitive, and visual-spatial tasks. These learners preferred hands-on activities, personal reflection, and holistic approaches to learning. By aligning both brain hemispheres, Kolb's model would contribute to a balanced learning process addressing analytic and creative dimensions to develop learners' engagement in learning by capitalizing on their cognitive strengths.

In a study by Robertson et al., (2000), functional magnetic resonance imaging (fMRI) was utilized to identify specific brain regions involved in comprehending coherent discourse. By presenting sentences containing definite or indefinite articles, the research revealed that processing connected discourse activated more neural activity in the right hemisphere than in the left. This suggests that the right hemisphere plays a more prominent role in higher-level cognitive mapping processes. Conversely, the left hemisphere was shown to be associated with lower-level reading tasks. The findings demonstrate the effectiveness of fMRI in investigating neural activity during complex cognitive functions like discourse comprehension. It also confirmed that the right frontal hemisphere is more effective in facilitating the mental representation of coherent discourse, while the left hemisphere contributes to fundamental reading processes.

Brain dominance influences students' performance on different vocabulary test formats, with right-thinking individuals excelling in picture identification and left-thinking individuals excelling in multiple-choice formats Kordjazi & Ghonsooly (2015). This study explored the link between brain dominance and test format by examining the hemispheric performance of 53 Iranian language learners across different test item formats, including multiple-choice synonyms, multiple-choice antonyms, word-for-word translation, and picture identification. The results indicated that brain dominance influences how students perform on various vocabulary test items.

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Two experiments assessed the efficacy of the keyword mnemonic method in adult learning. In the first experiment, adults using the keyword mnemonic method outperformed those using the repetition method. Participants, with a mean age of 59.35 years, learned 16 Latin words translated into Spanish. In the second experiment, participants learned 24 Latin words translated into Spanish using the keyword mnemonic method reinforced with pictures, resulting in significantly greater immediate and delayed recall compared to the repetition method group. The study concludes that the keyword mnemonic method enhances knowledge retention in adults (Campos, Pérez-Fabello & Camino, 2010). In their research, Campos et al. (2014) investigated the effectiveness of keyword mnemonics as a strategy for enhancing word recall in a non-dominant language among a sample of 237 students enrolled in Compulsory Secondary Education. Within this cohort, 102 students employed the keyword mnemonic method, while the remaining 100 students utilized traditional rote memorization techniques to learn the Spanish language. The findings of the study demonstrated that students who engaged with the keyword mnemonic strategy exhibited significantly superior performance in recalling word meanings compared to their peers who relied solely on rote memorization. This suggests that the keyword mnemonic method not only facilitated better retention of vocabulary but also enhanced overall language acquisition.

Consequently, the researchers concluded that keyword mnemonics are more effective than conventional memorization methods in aiding learners in mastering a second language. This study underscores the potential of keyword mnemonics as a valuable educational tool, highlighting its significance in fostering improved language retention and acquisition. The implications of these findings advocate for the integration of mnemonic strategies into language education, thereby enriching the pedagogical approaches used to support learners in their linguistic development. (Campos et. al., 2014)

Wyra, Lawson, and Hungi (2007) studied the mnemonic keyword method for vocabulary acquisition, examining its effects on the recall of word-meaning pairs. They investigated (a) training in keyword use during retrieval and (b) the influence of self-rated imaging ability. Results indicated that keyword method training during retrieval significantly improved recall performance. References related to this topic could include studies on left-brain dominance and learning styles, the use of mnemonic techniques for information retention, research on formative assessment, and analyses of student performance in educational settings. However, since these references are not directly provided in the original text, specific sources for each of these themes would require further research.

Literature Review

Brain-Based Learning

The Brain-Based Learning (BBL) theory is increasingly applied in science learning environments, particularly in Chemistry Education. A study involving 105 Saudi Arabian science teachers used a questionnaire survey to collect data. In a study conducted by Alanazi (2020), an experimental group consisting of 26 Grade 7 students engaged in a Chemistry curriculum designed around Brain-Based Learning (BBL) methods. The investigation aimed to assess the impact of this instructional approach on student knowledge and academic achievement. Findings from the study indicated that there were notable improvements in learning outcomes, suggesting that the BBL methods effectively enhanced the student's understanding of the subject matter.

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Despite these positive results, the research also revealed that factors such as teacher qualifications and years of experience did not significantly influence the outcomes of the student's learning. This highlights an important aspect of the study: while the learning design played a crucial role in fostering student engagement and comprehension, the characteristics of the teachers, including their formal qualifications and teaching tenure, were not determining factors in the observed improvements.

Overall, the study contributes to the existing literature on instructional strategies in chemistry education by demonstrating that innovative teaching methodologies, such as BBL, can lead to substantial gains in student performance, irrespective of traditional metrics of teacher effectiveness. This underscores the need for further exploration into the potential of alternative educational frameworks to support enhanced learning experiences for students.

A study by Funa, Ricafort, Jetomo, and Jr. (2024) explored the effectiveness of brain-based learning (BBL) as a pedagogical approach to address poor conceptual understanding. The findings concluded that applying BBL principles and strategies improved students' conceptual understanding at various levels in basic education for both English and STEM subjects.

Brain-based education applies strategies based on brain functionality principles, helping educators align instructional methods with learning conditions. This paper explores its potential to enhance education, transform classrooms, and improve teaching approaches (Laxman & Chin, 2010). Understanding the brain can revolutionize education and foster interactive learning environments.

Designing instructional methods that support cognitive learning processes can enhance athletic training education by managing cognitive load, stimulating long-term memory, and supporting the transfer of learning. Scientific evidence supports these methods, which can be incorporated into lesson design to improve learning outcomes (Clark & Harrelson, 2002).

The research by Albán, Ruperti, Tumbaco, and Martínez (2020) underscores the brain's crucial role in the teaching-learning process. Neuroscience supports this by revealing how neuroplasticity enables the brain to form new connections, enhancing learning and memory. Effective instructional methods manage the cognitive load to prevent overload, while positive emotions and adequate sleep boost memory and learning. Engaging students' attention and utilizing multisensory learning approaches create stronger neural connections, further supporting retention. Recognizing individual differences in cognitive abilities and learning styles allows for personalized education, optimizing learning outcomes. Understanding these brain-based principles helps develop better teaching strategies and more effective learning environments.

A significant study by Lim, Sim, and Tan (2021) utilized a deep-learning method to classify brain dominance based on electroencephalogram (EEG) signals, which reflect the brain's bio-information. The researchers employed various EEG signal processing techniques and a state-of-the-art deep learning neural network, the Metric Learning Based Convolutional Neural Network (MLBCNN), to determine brain dominance. The study validated the brain dominance theory, demonstrating that it can be analysed using machine learning from EEG signals, with the MLBCNN system achieving an accuracy of 97.44%. This method could significantly

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contribute to education by providing a system to identify students' brain dominance and monitor their training progress, thereby fully unleashing their brain's potential and capabilities.

The brain hemispheric dominance theory posits that individuals may exhibit a preference for either right-brain or left-brain processing, while some are classified as whole-brained when both hemispheres function relatively equally. This paper examines the neurological phenomenon of brain hemispheric dominance, where one hemisphere exerts greater influence in the use of specific cognitive functions. Although structurally similar, the right and left hemispheres differ functionally. Drawing from empirical studies, this paper explores these functional distinctions and provides a deeper understanding of brain dominance theory and its educational implications for enhancing teaching and learning strategies (Rai & Singh, 2022).

The Mnemonic Keyword Method

The Mnemonic keyword method is widely used in teaching foreign languages, as it helps link unfamiliar foreign vocabulary to familiar English words, facilitating easier recall and understanding.

Mnemonic techniques, known as the "keyword method" (Atkinson, 1975; Raugh & Atkinson, 1975 & Pressley et al., 1982), enhance learning and improve memory retention. Introduced by Atkinson in 1975, this versatile method aids in encoding information for easier recall, particularly in teaching both local and foreign language vocabulary and meanings.

The mnemonic keyword method generally applies to foreign language learning by creating a phonetic and visual link between the foreign words learned and their native equivalent. This method connects unfamiliar words with similar-sounding English words, helping learners encode meaningful associations between the keyword and the foreign term. It is particularly effective for recalling vocabulary definitions. Pressley et al. (1982) in their studies concluded the effectiveness of the mnemonic keyword approach in aiding students to retain the vocabulary meanings and contribute to a high level of academic performance. However, research on its application to learners' performance to manage the subject contents is limited (Lim & Kim, 2003; Song, Singleton, Hill & Koh (2004); Shapiro & Waters (2005); Wyra, Lawson & Hungi (2007). The keyword approach is applicable for the right and left-brainers, particularly in dealing with abstracts or unknown as well as unfamiliar information into clear and understandable concepts, and increases the transfer of learning.

Another study was conducted testing the application of the Mnemonic Keyword Approach to low-proficient English learners amongst 44 students of first-year university students studying a non-credit English remedial course. The study involved 40 target vocabulary words, with one group of students employing the Mnemonic Keyword Method (MKM) and the other group utilizing a mixed-method approach. The mixed-method group was provided with contextual clues, word structure analysis, and antonym pairs. The study aimed to measure students' knowledge retention using a 40-item vocabulary test. Results revealed that the MKM significantly enhanced both short-term and long-term vocabulary retention, particularly among low-proficiency English learners, when compared to the mixed-method approach (Siriganjanavong, 2013). This finding underscores the effectiveness of MKM in facilitating enduring retention of vocabulary.

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Teaching methods and techniques are crucial in enabling students to apply and reflect on theoretical content, fostering the acquisition of knowledge, and the development of competencies. This approach has proven particularly effective in the field of business administration, specifically in the subject "Organizational Structure and Behavior" within the Business Administration and Management degree. By integrating practical applications into theoretical instruction, the teaching methods have successfully achieved the learning objectives. Additionally, they have improved student satisfaction, enhanced learning quality, developed digital competencies, and increased interest in the subject (Gómez López et al., 2022).

Numerous educational applications are being explored, particularly for teaching reading courses that require absorbing and comprehending large amounts of content. Mnemonic training effectively enhances memory performance by optimizing brain network function. A study by Dresler et al. (2017) used fMRI to examine the functional brain network organization of 23 top memory athletes and matched controls after six weeks of mnemonic training. The study found that mnemonic training significantly improved the athletes' memory, with effects lasting up to four months post-training. Overall, the study concluded that mnemonic techniques enhance brain network organization, leading to superior memory performance.

The Purpose of Study

The study aims to investigate how individuals with a left-brain orientation comprehend and manage information overload using the Mnemonic Keyword Approach. The objectives are to evaluate academic performance in formative assessments for the ENT300 university course (Fundamentals of Entrepreneurship) and the application of the Keyword Approach in answering the assessments. This research seeks to determine how the Mnemonic Keyword Approach affects understanding and information retention among left-brained learners, who are generally less capable of retaining large amounts of information. It is also to evaluate the effectiveness of the Mnemonic Keyword Approach in the teaching and learning process of the ENT 300 course. The ENT 300 Quiz, a formative assessment, was analysed to assess this method. Lecturers simplified the course content into formulas or equations to help students retain and recall key points more easily. The quiz answer sheets were examined to determine how students used mnemonic keywords to provide correct answers, either in the form of keywords, key points, or explanations. The presence of these keywords in students' answers indicates their knowledge retention and the effectiveness of the Mnemonic Keyword Approach.

In addition, this case study is designed to evaluate students' understanding and retention of the materials taught in the Fundamentals of Entrepreneurship course, which is part of the curriculum under the Faculty of Business and Management. The primary focus is how well students can capture and store the information learned in their memory. Unlike engineering subjects that students might be more familiar with, the content of this course is entirely new to them, presenting unique challenges and learning opportunities. The aim is to help students grasp the principles of entrepreneurship effectively, which is a significant departure from their usual academic experiences. This subject is distinct from engineering courses and is entirely new to the students specifically the Science & Technology fields.

The brain hemispheres function differently, and this distinction has a notable impact on graduates' learning activities. This case study focuses on the application of the Mnemonic Keyword Method in the subject ENT300 (Fundamentals of Entrepreneurship), which covers a

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wide range of business management topics. These include manpower planning, employment perspectives, market demands, product development, sales forecasting, operational management, production planning, and financial performance, including business accounting principles.

ENT300 is often perceived negatively by technical students, particularly those in Science and Technology (S&T) fields, who are typically left-brain dominant. During ice-breaking sessions, it was observed that 70% to 85% of these students had unfavorable perceptions of the subject. Their concerns stemmed from several factors, including its perceived irrelevance to their fields of study, the heavy reliance on group assignments, and the complexity of business-related terminologies. These negative perceptions highlight the challenge of engaging left-brain learners in subjects that deviate from their technical expertise.

The negative perceptions surrounding ENT300 (Fundamentals of Entrepreneurship) among technical students, particularly those in Science and Technology (S&T) fields, have highlighted the need for innovative teaching methods that cater to their specific learning styles and cognitive strengths. Left-brain dominant learners, who are typically more analytical, logical, and detail-oriented, often struggle with subjects that appear to lack structure or seem unrelated to their core fields. The abstract nature of business terminologies and concepts, coupled with group-based assignments, makes it challenging for left-brainers to engage fully with subjects like ENT300, which are outside their technical comfort zones.

In response to this challenge, lecturers have adapted their teaching methods by transforming complex and lengthy information into simplified, structured formats that align with left-brainers' cognitive processing preferences. This approach involves converting lengthy sentences and abstract business concepts into concise keywords, formulas, or equations. Left-brain learners thrive on structure and organization, so presenting information in a logical, step-by-step manner enables them to better absorb, process, and retain knowledge.

By breaking down large volumes of information into smaller, more manageable pieces, students can more easily identify and memorize key concepts. This method also helps them to recall these keywords when needed, allowing them to build upon foundational knowledge systematically. For instance, when faced with complex business concepts, left-brainers can rely on the simplified keywords to construct comprehensive responses, transforming abstract ideas into more concrete, understandable elements. This structured learning approach mirrors the sequential and logical way left-brainers process information, ensuring that they can effectively grasp, retain, and apply the material.

Additionally, this pedagogical strategy addresses the brain dominance of these students, engaging their cognitive strengths and reducing the cognitive overload they experience when dealing with unstructured information. By introducing keywords and formulas that appeal to their analytical nature, the lecturers make the content more relatable and accessible to left-brain learners. This not only helps them understand the relevance of the subject to their future careers but also increases their engagement and interest in the material.

Furthermore, by aligning the teaching approach with left-brain learning styles, this method promotes deeper understanding and long-term retention of the material. Left-brainers prefer learning environments where they can analyse and break down information into logical

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segments, and this method leverages that preference. It allows students to manage comprehension more effectively, particularly in a subject that initially seemed disconnected from their technical backgrounds.

As a result, this teaching technique has been shown to significantly enhance students' engagement with the ENT300 subject, making the learning process more interactive and meaningful. By catering to their brain dominance and cognitive preferences, this approach not only helps them succeed academically but also demonstrates how entrepreneurship concepts can be applied in their future roles as engineers. This newfound relevance and understanding foster greater interest and motivation, bridging the gap between business-related content and the students' technical fields.

In summary, the Mnemonic Keyword Method, adapted for left-brain learners, helps them overcome the challenges associated with information overload and abstract content by providing a structured, sequential way to learn. This approach not only addresses their cognitive needs but also transforms their perceptions of the subject, ultimately enhancing their comprehension, retention, and overall learning experience in ENT300. From the perspective of learning styles and brain dominance, educators are tasked with modifying, adapting, or even enhancing their teaching methods, tools, and techniques to accommodate students' cognitive preferences. Recognizing the diverse ways in which learners process information, particularly in relation to left- and right-brain dominance, requires a strategic approach to instruction that aligns with these cognitive styles. To enhance academic performance in the classroom, especially for left-brain learners, it is crucial to adopt teaching strategies that provide structure and logic.

One effective approach involves converting complex or abstract content into simplified, memorable formulas or equations. This method aids students in digesting large amounts of information more efficiently and enables them to better comprehend and retain key concepts. By transforming lengthy sentences into straightforward, easily recalled formats, educators can create a more engaging and accessible learning environment. Such tailored teaching methods not only cater to the students' cognitive strengths but also foster a deeper understanding of the material, improving overall academic performance.

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Data Collection and Evaluation Process

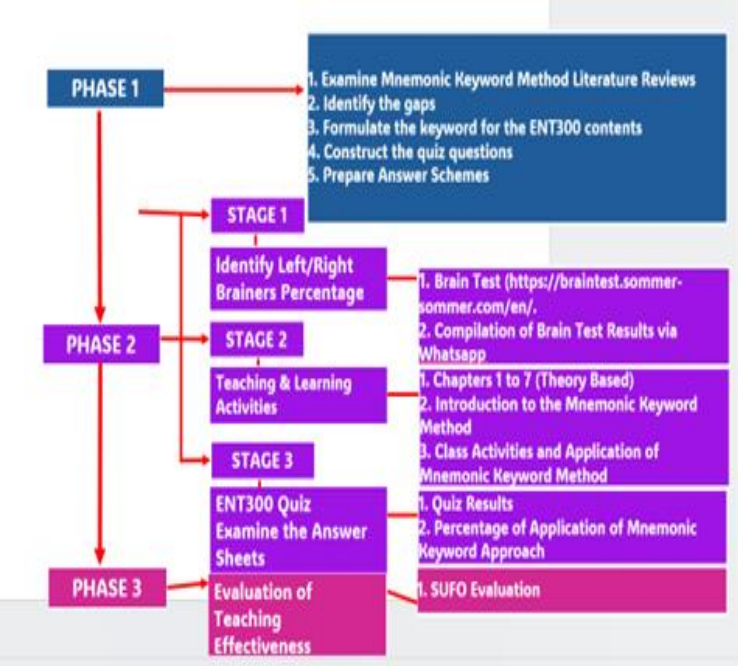

Diagram 1: Three Phases of the Application of Mnemonic Keyword Method in the Teaching and Learning Activities

This case study consisted of three key phases, each with distinct activities to examine the effectiveness of the Mnemonic Keyword Method in teaching and learning. Below is a breakdown of the phases:

Phase 1: Preparation and Review
The first phase focused on gathering and organizing the necessary foundational materials:

Phase 1: Activities

- Examined and re-examined the latest empirical studies on Mnemonic Keyword Methods.
- Compiled a comprehensive Literature Review on the subject.
- Identified research gaps in the existing studies.
- Formulated keywords for the ENT300 course content.
- Constructed quiz questions based on the formulated keywords.
- Prepared the answer scheme for evaluating the quizzes.

Phase 2: Teaching and Learning Implementation
Phase 2 was broken down into three stages, which included both the identification of brain dominance and the application of the Mnemonic Keyword Method.

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Phase 2: Stages	Activities
Stage 1: Identifying Brain Dominance	- Students took an online Brain Test (https://braintest.sommer-sommer.com/en/) to identify their left- or right-brain dominance. - Results were shared via the class WhatsApp group for further analysis.
Stage 2: Conducting Teaching and Learning Activities	- Covered Chapters 1 to 7 (theory-based chapters). - Introduced students to the Mnemonic Keyword Method. - Conducted class activities where students applied the method by identifying, classifying, and converting content into mnemonic devices. - Encouraged students to create formulas, mathematical symbols, equations, and phonetic representations based on chosen alphabets.
Stage 3: Administering ENT300 Quiz	- Conducted a quiz and examined the answers to assess the application of the Mnemonic Keyword Method. - Analyzed the percentage of students utilizing the method in their quiz responses.

Phase 3: Evaluation of Teaching Effectiveness
The final phase focused on evaluating the effectiveness of the Mnemonic Keyword Method through student feedback.

Phase 3: Activities
- Evaluated teaching effectiveness using SUFO (Students' Online Feedback). - Analyzed the feedback to assess the impact of the Mnemonic Keyword Method on quiz performance and overall learning.

This structure clarifies the process and activities involved in each phase, presenting a coherent and comprehensive account of the case study. The table format enhances readability and organizes the content effectively.

The study involved 59 final-semester Science and Technology students from UiTM Pulau Pinang's Mechanical Engineering Faculty, enrolled in the ENT300 course from October 2023 to February 2024. Students are required to assess their brain dominance either right-brainer or left-brainer using the testing tool available at https://braintest.sommer-sommer.com/en/. The https://braintest.sommer-sommer.com/en/ testing tool or platform offers nine stages of brain examination options to choose from. The brain test was developed by Gordon and Leonard Sommer in July 2012. Presently, it is more than 26 million people have taken the brain test, it is a recognized worldwide hit. The results were shared by students via WhatsApp. Based on the results, the lecturers would be able to determine the percentage of left-brainers and right-brainers for each class. According to Sommer et. Al (Sommer et al., 2022), the human brain

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operates in two different thinking modes, and each person tends to favor one mode more than the other. However, both the left and right sides of the brain work together, enhancing learning and boosting overall brain power. In this process, the brain encodes information through patterns of neural activity. Based on the brain testing, 78% of students were in a category of Left Brainers ranging from 53% to 83%, Right-Brainers, 15% with a percentage from 53% to 69%, and whole-brained, 7% when both hemispheres function relatively equally at the cut-off points of 50:50 for both hemispheres.

The Mnemonic Keyword Method has proven to be a reliable and effective strategy for enhancing the learning process, particularly in improving knowledge retention and comprehension of subject content. In this context, the method was applied to the university course "Fundamentals of Entrepreneurship" (ENT300), demonstrating its potential to facilitate deeper understanding and recall of complex topics covered in the curriculum.

The ENT300 formative assessment is the form of a quiz, which accounts for 20% of the total assessments. The learning outcomes for ENT300 are CLO1 - To explain the principles of entrepreneurship using verbal and non-verbal communication, and CLO2 - To demonstrate the entrepreneurial mindset in identifying business opportunities. The quiz featured questions on fundamental concepts of entrepreneurship and aspects of the Business Model Canvas (BMC).

The quiz questions demand a comprehensive understanding of the subject, including the definition of terms and the nine components of the Business Model Canvas (BMC). Students must recall definitions from various philosophers, clarify entrepreneurial competencies, and provide short explanations for each BMC component in the appropriate columns. This requires students to organize relevant content and recall all components, offering concise descriptions. The quiz is designed to test their memory and understanding of the required material.

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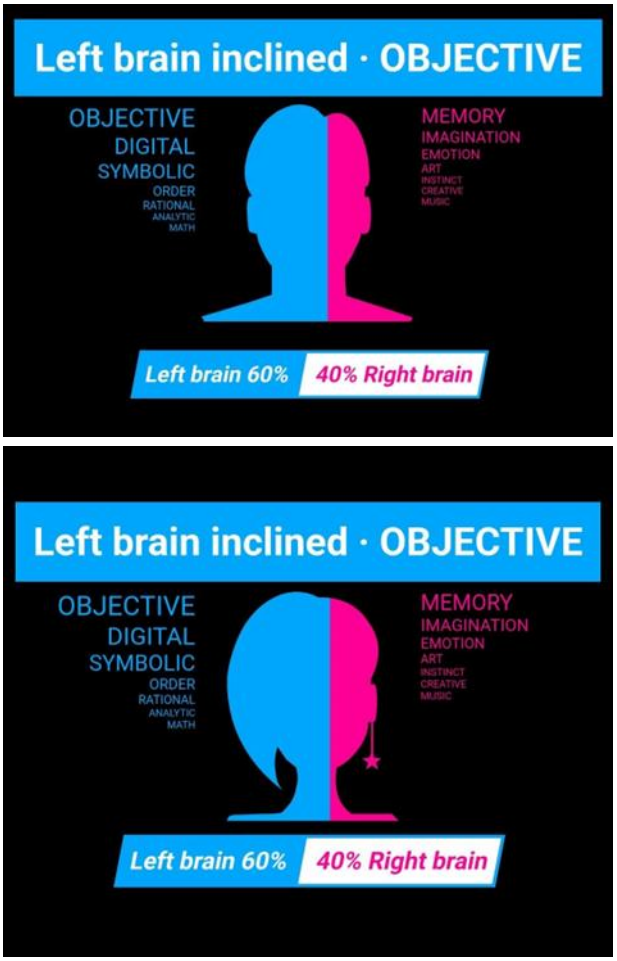

Figure 1: Samples of Brain Test Results

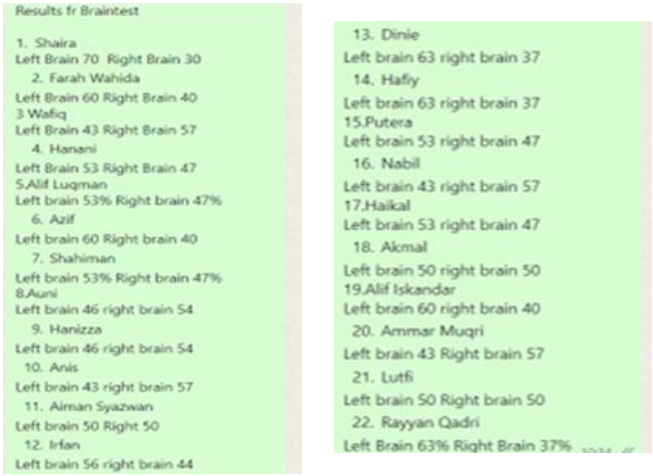

Figure 2: Sample of Brain Test Results in Percentage and Shared Via WhatsApp

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Results and Discussions

Quiz analysis showed that 87.5% of students used keyword formulations to identify definitions, competencies, motivational components, and BMC elements, using themes, repetitive characters, and phonological patterns as mnemonic devices. The quiz results obtained by students are in a range of 75 – 97.75/100 (20%).

Some of the formulas used by the students are;

Definitions of Entrepreneurship by Philosophers
- Adam Smith: Agent (Ad = Ag)
- John Stuart Mill: Prime Mover (Mill = Mover)
- Ibnu Khaldun: Knowledgeable Person (Kh = Kn)
(This is based on the Phonetic Alphabet)

Motivation
- The Need for Achievement (n Ach), Power (n Pow), Affiliation (n Aff)
- Mo = n (APA)

Business Model Canvas (BMC)
- Customer Segments (C), Relationships (R), Value Propositions (V), Key Resources (KR), Key Activities (KA), Key Partnerships (KP), Channels (Ch), Cost Structure (Cs), Revenues (R)
BMC = CRV + K(PAR) + CCR
(The formula/equation is further simplified to limit the alphabet)

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Table 1: Samples of Quiz Results

STUDENTS	ENT300 QUIZ (100%)	STUDENTS	ENT300 QUIZ (100%)
1	94	31	93.5
2	91.5	32	81
3	86	33	86.25
4	80.5	34	90.5
5	75	35	76
6	90	36	91
7	97.75	37	80
8	96.5	38	98
9	85.25	39	90.75
10	90.75	40	92
11	94	41	91.5
12	94.5	42	90.5
13	75.75	43	88
14	94.5	44	92.5
15	88.5	45	96
16	91.75	46	75.5
17	92.5	47	83.5
18	90	48	87.25
19	93	49	93
20	83.75	50	95.5
21	87	51	90.5
22	96	52	92
23	95	53	91.5
24	96	54	92.5
25	95	55	86.75
26	94	56	91
27	91	57	80
28	92.5	58	94.5
29	94.5	59	93.5
30	84.5		

STUDENTS	ENT300 QUIZ (100%)
1	94
2	91.5
3	86
4	80.5
5	75
6	90
7	97.75
8	96.5
9	85.25
10	90.75
11	94
12	94.5

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13	75.75
14	94.5
15	88.5
16	91.75
17	92.5
18	90
19	93
20	83.75
21	87
22	96
23	95
24	96
25	95
26	94
27	91
28	92.5
29	94.5
30	84.5
31	93.5
32	81
33	86.25
34	90.5
35	76
36	91
37	80
38	98
39	90.75
40	92
41	91.5
42	90.5
43	88
44	92.5
45	96
46	75.5
47	83.5
48	87.25
49	93
50	95.5
51	90.5
52	92
53	91.5
54	92.5
55	86.75
56	91
57	80

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58	94.5
59	93.5

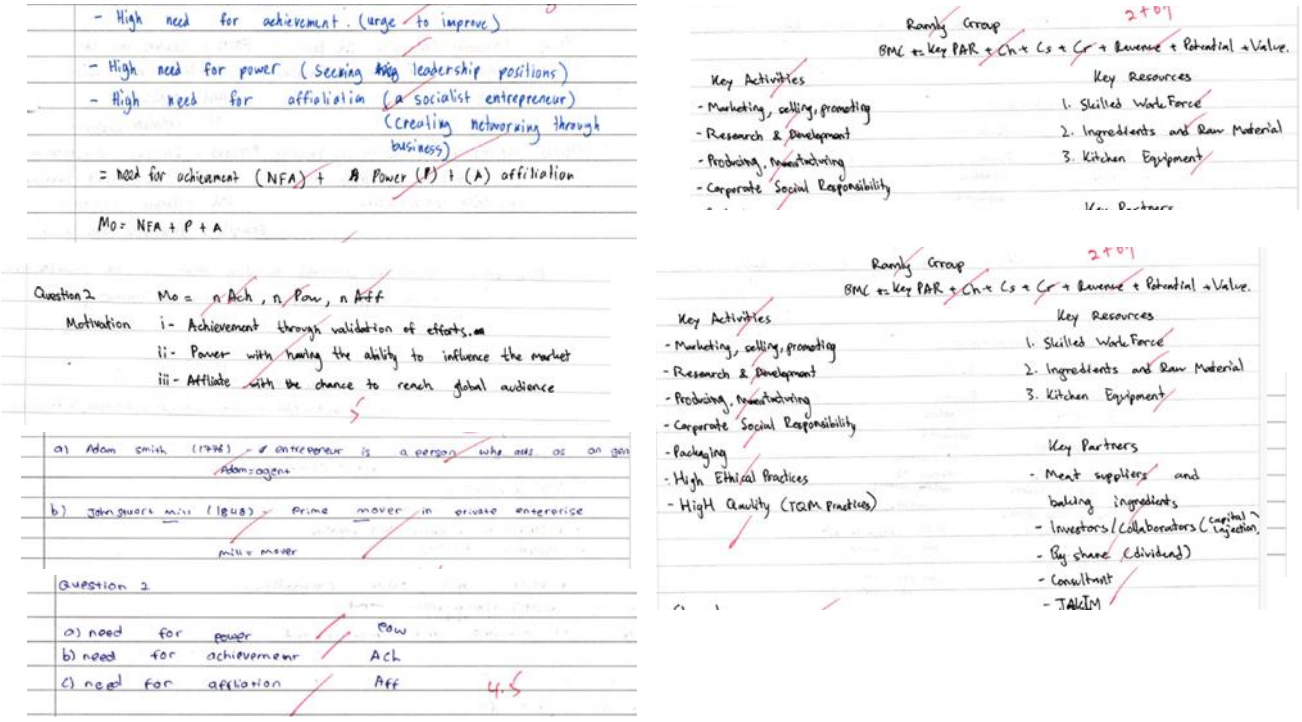

Figure 3: Samples of Formative Assessment (Answer Sheets)

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Table 2: SUFO Results

18	Kaedah penyampaian pensyarah sangat menarik. *The lecturer delivers the content interestingly.*	0	0	3	10	94.23	3.77
19	Kaedah penyampaian pensyarah sangat mencabar minda. *The lecturer's delivery style challenges the mind.*	0	0	3	10	94.23	3.77
20	Pensyarah memberi maklumbalas bagi setiap penilaian/tugasan/ujian/projek. *The lecturer provides feedback for each assessment/assignments/tests/projects.*	0	0	3	10	94.23	3.77
21	Pensyarah membantu pelajar menguasai kandungan pembelajaran. *The lecturer helps students master the learning content.*	0	0	4	9	92.31	3.69
22	Secara keseluruhannya, saya seronok dengan pengajaran pensyarah ini. *Overall, I enjoyed the teaching style of this lecturer.*	0	0	3	10	94.23	3.77
Jumlah Purata Keseluruhan ***Grand Average Total***							
	JUMLAH PURATA KESELURUHAN :	**0**	**0**	**90**	**222**	**92.52**	**3.70**
	PRESTASI ((SECTION B + SECTION C) / 2) :	**0**	**0**	**64**	**170**	**93.21**	**3.73**
	PETUNJUK PRESTASI (PERFORMANCE INDICATOR) :	**Excellent**					

The Student's Feedback Online (SUFO) was scrutinized to assess the practicality and applicability of the Mnemonic Keyword Method in evaluating teaching and learning effectiveness. Students were encouraged to evaluate not only the course content but also the teaching methods and tools used to aid their understanding. The results demonstrated a significant improvement in students' retention of key concepts taught in class. By employing the Mnemonic Keyword Method, students were better able to recall and list essential factors, contributing to enhanced performance in quizzes.

This teaching method proved highly effective in addressing information overload, as students could systematically memorize and recall content through the use of meaningful formulas, coding, and abbreviations. The structured approach allowed for easier retention of complex information, resulting in improved quiz scores and greater overall comprehension. Ultimately, the Mnemonic Keyword Method facilitated better knowledge retention and a more effective learning process, highlighting its adaptability in various educational settings.

The adaptive teaching approach, through the application of the Mnemonic Keyword Method in classroom instruction, significantly enhanced memory retention for theory-based subjects containing unfamiliar terminology and jargon, which markedly differ from students' usual subjects. This pedagogical strategy proved particularly effective in helping students grasp complex, abstract concepts that are otherwise challenging to comprehend. As a result, the approach demonstrates its broader applicability to other reading-intensive subjects across diverse academic disciplines. By tailoring teaching methods to support cognitive engagement and retention, this technique shows potential for improving learning outcomes in a wide range of theoretical and content-heavy courses. The outcomes prove there is a significant relationship between knowledge retention with the application of the keywords and revealed the impact of the teaching methods addressing brain dominance. The effectiveness, applicability, and reliability of the Mnemonic Keyword Method are unequivocal, despite its initial use primarily in foreign language acquisition. Through comprehensive analysis of the Student's Online

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Feedback (SUFO), this method has been validated as a versatile tool, demonstrating its usability across a broader range of subjects. The positive feedback from students indicates that this approach can be effectively adapted to disciplines beyond language learning, offering substantial benefits in improving comprehension and retention of complex material. The SUFO's evaluation was conducted for items No. 18 (The Lecturer delivers the content interestingly), No. 19 (The Lecturer's Delivery Style Challenges the Mind), No. 21 (The Lecturer Helps Students Master the Learning Contents and No. 22 (Overall, I Enjoyed the Teaching Styles of this Lecturer in the range of 92.10% to 97.31. The results indicated an outstanding measurement level of its application.

Conclusion

The Mnemonic Keyword Method helps left-brained students manage information overload and retain content. This study explores its effectiveness for non-technical subjects, showing that matching teaching methods with brain dominance improves learning. Educators can enhance outcomes by tailoring methods accordingly. It also aligns with previous empirical studies on adaptive teaching which is an instructional approach where educators modify their methods to meet students' individual needs and levels of understanding. This approach fosters a supportive and engaging learning environment, empowering students to take control of their learning, explore their interests, and maximize their potential. It is essential for promoting high-quality learning and has proven effective in both one-to-one and small-group settings. A study by Hardy et al., (2022) applied adaptive teaching to enhance the conceptual understanding of 341 elementary students on the topic of "floating and sinking," demonstrating its effectiveness in promoting long-term learning outcomes as evidenced in the final post-test.

The Mnemonic Keyword Approach is an effective strategy for improving memory retention and knowledge recall, particularly for left-brain dominant learners. By converting complex information into simple, catchy formulas, this method aligns well with the structured and analytical thinking style of left-brainers. Applied to reading-intensive subjects like ENT300 (Fundamentals of Entrepreneurship), it helps students better understand and retain theoretical concepts by simplifying unfamiliar terms into memorable cues.

This approach also has broader educational implications. Identifying students' brain dominance allows educators to tailor teaching methods to align with cognitive strengths. Left-brain learners thrive with structured materials, while right-brain learners benefit from more creative and intuitive approaches. Adapting curricula to match these learning preferences fosters a more engaging and effective learning environment.

The objectives of the case study were accomplished, demonstrating that the Mnemonic Keyword Approach enhances academic performance while promoting personalized learning, making it a valuable tool for maximizing students' cognitive potential.

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