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Effects of Mental Imagery and Levels of Processing on Analogy Problem Solving among Undergraduate Students

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Abstract

This study examined the effects of mental imagery and levels of processing on analogy problem-solving ability of undergraduate students. Participants (N = 138) were second and third level undergraduate students of Ebonyi State University, Abakaliki. There were 69 males and 69 females. Their ages ranged between 18 and 30 years (M_{age} = 22.57, SD = 5.72) were selected through simple random sampling. Participants were tested on analogy problem solving. Two hypotheses were stated and tested. The results revealed that a significant mean score difference exist between participants who possessed the high mental imagery and others who utilized the low mental imagery on analogy problem solving, F (1, 134) = 6.93, P<.05. Also, participants who used the high mental imagery showed superior analogy problem-solving ability than participants who used the low mental imagery on analogy problem solving. Further, results indicated that a significant mean score difference exist between deep and shallow participants on analogy problem solving, F (1, 134) = 10.85, P<.05. A significant interaction effect of mental imagery and levels of processing was also found, indicating that neither mental imagery nor levels of processing had a simple independent effect on analogy problem-solving ability, F (1, 134) = 6.28, P<.05. This study recommend that undergraduate students, pupils and other higher learners should be encouraged and supported to learn the processes of mental imagery formation and levels of processing as this led to societal problem solving and students' academic achievement.

Keywords: ***Mental imagery, levels of processing, analogy, problem solving, undergraduate Students.***

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Introduction

Problem solving ability is one of the greatest abilities that humans possesses, and has remained a constant factor in the community or society as every societal problem demands solutions. This is because problems of different types or forms are essential part of the global community, without which humans cannot contribute to the society, make impact and cope with complex problems encountered in daily life. Although problem is a universal phenomenon implying challenges, as well as issues within the society; different societies and generations may be faced with peculiar problems requiring peculiar problem-solving techniques (Bal et al., 2023; Mefoh, 2021; Nwonyi, 2021).

Problem is quantitative situation that requires a solution regardless of the availability of the problem solver's existing knowledge (Xu et al., 2023). Fülöp (2021) stated that the problem changes based on the person assigned the task and emphasized that the person should be willing to solve the problem. As such, particularly in cognitive psychology and mathematics where students are expected to make sense of heuristic(analogy) and algorithms to solve problems as well as associate this information with daily life based on available data, analyze, make inferences, and gain advanced thinking skills and decision making (Evans et al., 2020; Han et al., 2020)

Problem solving involves engaging a complex set of cognitive, affective, and behavioural skills in order to identify potential options available for obtaining or achieving the intended outcome; and interacts with other cognitive activities including learning, inference, abstraction, synthesis and retrieving of information that leads to better learning for problem solving (Corral et al., 2023; Corral et al., 2020; Mefoh, 2021). Problem-solving process refers to mental representation and cognitive process of the brain that requires different strategies to be used together. Hence, during problem solving, meaningless results may be reached if the right strategy to solving the problem is not utilized by the students (Corral et al., 2020; Xu et al., 2023). Studies on problem-solving are generally classified as problems as well- and ill-defined (Evans et al., 2020; Mefoh, 2021; Xu et al., 2023). In a well-defined problem, the correct formulation is given that is, the problem is presented with the expectation that the current state, goal state, and operators will be sufficiently obvious to allow steady progress toward the goal. This enables students to develop skills, knowledge and abilities to solve daily problems such as heuristic (analogy) and algorithms to solve problems. Ill-defined problems are those that do not have clear goals, solution paths, or expected solution or ill-defined problem, uncertainty inheres not only in whether the goal will be reached but in how best to conceive the current state, goal state, and/or operators. This enables students to develop problems skills that require the use of many metacognitive skills such as logic, establishment of appropriate hypotheses, and interpretations of problems (Han & Kim, 2020; Ozenc et al, 2021).

Problem solving strategies are systematic approaches or processes that guide the selection, implementation, and evaluation of various operators (actions) in order to move effectively from the initial problem state to the desired goal or outcome (Evans et al., 2020; Koichu et al., 2003; Ohlsson, 2012). Reisberg (2007) argued that two main methods to study complex problem solving, which have different emphases, are algorithm and heuristics. Algorithms are procedures or strategies that will always ensure a successful solution (assuming correct application) whereas heuristics, essentially procedural or strategic shortcuts based on experience, do not guarantee a successful outcome or that the best possible option available will be identified (Condell et al., 2010; Jonassen, 2010; Billing, 2007). But the focus of this study is heuristic problem (analogy problem solving). Heuristic problem-solving strategies includes association, critical thinking, and analogy. The problem-solving strategies of interest in this present study is analogy problem solving. Analogy is a fundamental cognitive process in which a source (a known piece of information) and a target (a problem or current domain of knowledge) are linked to one another by a systematic mapping of attributes and/or relations, which then allows for transfer of existing knowledge to the target (Ichien et al., 2020).

Analogical problem solving is an inferential strategy that consists of adapting a solution procedure from a previously encountered and understood problem to resolve a new problem that shares significant underlying relational similarities or correspondences (Evans et al., 2020; Ozenc et al., 2021). Analogical problem solving models suggest that analogical problem solving consists of a series of component processes centred on the transfer of deep structural characteristics from the base to the target problem leading to the formation of problem solving schemata and these include: representation, retrieval, mapping, adaptation, and learning (Israel, 2019, Li, 2020; Oluwadayo et al., 2024). Examples of analogy problem solving of interest in this currents research are (1). The radiation problem (Duncker, 1945) where a doctor faced with a patient who has a malignant tumor in his stomach. (2). the attack-dispersion story where a general wishes to capture a fortress located in the center of a country.

Another important variable of interest in this study is mental imagery. A phenomenological approach to understanding individuals' experience of mental imagery when performing a memory task such as problem-solving task was employed in an attempt to understand the complexity of individuals experience of mental imagery and analogy problem solving (Mefoh,2015). Imagery as the process by which information about an object stored in long-term memory is reactivated to give rise to a visual representation of its physical attributes that can then be revisualized and inspected (Sergent.1990). Mental imagery is defined as the mental invention or recreation of an experience that in at least some respects resembles the experience of actually perceiving an object or event, either in conjunction with, or in the absence of, direct sensory stimulation (Finke, 1989). Accordingly, a mental image is the internal recreation or representation of a sensory perception and may involve multiple sensory modalities such as non-visual modalities which play a significant role in creative problem solving.

Mental imagery, also known as visualization refers to the process of creating or recreating experiences in your mind. Mental imagery can also significantly impact our learning, problem-solving, and creativity. It's frequently employed in the learning process. When trying to understand complex theories or memorizing information, creating a mental image can simplify and enhance comprehension. In problem-solving, individuals, undergraduate students, pupils, often visualize different scenarios and solutions, which aids in decision-making and conclusions.
Miller (1984) categories mental imagery into auditory, sensual, and visual modes which play a central role in creative thought and problem solving. Mental images are potentially comprised of visual, auditory, gustatory, olfactory and/or tactile/kinesthetic sensations. Mental images that are perceived in the visual modality are described as pictorial if they represent the perception of scenery or solid forms, like but not limited to photographic representations.

Forisha (1978) concludes that one of the explanations for inconsistent and inconclusive relationships reported between mental imagery and memory, such as creativity, problem solving is the failure of researchers to consider the complexity of imaginal processes such as visual imagery. These assertions lead to current research on effects of mental imagery and levels of processing on analogy problem solving.

Another interesting variable in this research is levels of processing. Levels of processing refers to an alternative to the stage theory of memory stating that the memory is a matter of degree rather than different kinds of memory and is based on how incoming information is processed (Craik et al., 1972). Craik and Lockhart, (1972), proposes that during memory processes of receives, encoding, modifies, retains and retrievers of information from long-term memory. The types of processing lead to different levels of memory retention and retriever of performance which includes deep and shallow levels of processing of information in both external and internal environment. Deep processing involves processing information at a semantic level, such as its meaning and relevance.

Deep processing which involves greater attention and elaboration of information in the memory during the encoding phase or when processing of information centers on meaning. Deep processing leads to better memory. This is because deep processing involves elaboration, which involves relating new information to existing knowledge and creating meaningful connections. Elaboration increases the likelihood of encoding information into long-term memory, making it easier to retrieve later. Deep processing leads to better memory recall, recognition, creativity decision making and problem solving ability. Semantic processing also leads to better memory recall than phonemic processing because it involves processing the meaning of information. Shallow processing, which involves the encoding of superficial, perceptual information in the memory or when processing is keyed to superficial aspect of new information or involve paying little attention to stimulus meaning. (Rack, 1979) maintained that levels of processing model have two central themes, first, semantic analysis which results in a deeper memory code of a more meaningful code than does of a non-semantic analysis which involved lesser memory code. Secondly, the deeper the code, the more durable the memory, meaning that forgetting is simply a function of depth of processing. People forget things that they have not processed semantically. The fundamental concept of the levels of processing by Craik and Lockhart (1972) is that different methods of encoding information into memory results in different types of memory codes.

Statement of Problem

Problem solving has remained an important feature of human existence and a unique factor that humans cannot do without. Today and especially among developing countries, a major challenge of education is improving human cognitive ability to solve complex problems in their daily life (Nwonyi, 2021). A number of researchers (Abassah, 2011; Adedokun, 2011; Akinyemi et al., 2012; Mefoh, 2021; Mefoh, et al., 2014; Nwonyi, 2021; Oyesiku, 2008; Umunadi, 2011; Uwaifo, 2010; Uwaifo et al., 2009) reported that school leavers from Nigerian school's lack problem solving abilities, creativity and decision making in our society today, and suggested that more research should be conducted to address this menace. There has been little experimental investigation of analogical problem solving in more complex problem-solving tasks especially in the area of mental imagery and levels of processing using attack-dispersion and radiation problem solving using non-western sample (Nigerian students) therefore more research is needed for verification.

From the empirical studies reviewed, some of those studies were done outside Nigeria context such as (Kawahara, 2021; Loaiza et al., 2011; Magyari et al., 2020; Patel et al., 2015; Wyra, 2019) and few was undertaken in Nigeria (Mefoh, 2021; Mefoh, et al, 2014).Their studies however, differs from the present study because it did not consider the combining

effects of mental imagery and levels of processing on analogy problem solving among undergraduate students in Nigeria. More so, studies done in Nigeria on problem solving were largely with secondary school students; hence, this study will involve undergraduate students who have undergone series of creativity trainings under entrepreneurship. Moreover, the inability of those empirical studies to give more attention on the effects of mental imagery and levels of processing on analogy problem solving created a gap in knowledge. In addressing the problems raised in the study, the following research questions are stated to guide the study.

1). Would mental imagery (high and low) affect analogy problem solving among undergraduate students?
2). Would level of processing (deep and shallow) effect analogy problem solving among undergraduate students?

Theoretical Review

The following theories were examined in the light of their importance to the study: information-processing models of problem-solving Newell et al. (1972) which stated that problem solving is influenced by people's information processing capability as determined by STM (short term memory) and LTM (long term memory), the structure of the problem and its effect on the search for a solution and the effectiveness of different strategies and sources of information. Also, the models suggest that analogy may be an important strategy for dealing with the many instances of uncertainty that occur in problem solving.

Alkinson et al. (1968) model of information processing believed that learning and memory as discontinuous and multi-staged which implies information are transferred from sensory registrar to short term memory and finally to long term memory for retriever. Craik et al. (1972) levels of processing framework proposed that levels of processing model have two central themes, namely: that semantic analysis results in a deeper code of a more meaningful code than does a non-semantic analysis(shallow) and that the deeper the code, the more durable the memory and the ability to solve complex problem

Piaget (1975) developmental theories of mental imagery suggested that mental imagery is necessary for environmental interactions, the development of abstract principles, and problem solving such as analogy problem solving

Quasi-pictorial theory of imagery (Craig et al., 2011; Stuart et al., 2011) suggest that a very strong role of mental imagery on problem solving. The scholars explained mental imagery using the quasi-pictorial theory of mental imagery. Once the quasi-picture is established on the buffer it is available to consciousness as an image, and information that was merely implicit in the deep representation can be extracted from it by a postulated mind's eye function that enable student to retrieve past processed information and use to solving the present problem. These theories combined to give the study a theoretical based.

Empirical Review

Mental imagery and analogy problem solving

Kawahara (2021) examined the effects of mental imagery in the solution-focused approach by evaluating the impact of positive self-image about the future on emotional states using the time machine question (which is a questioning technique used in the solution-focused approach). The researchers compared the change in the emotional state of 270 subject, using the Japanese version of the positive and negative affect schedule, before and after the intervention. The intervention conditions included: verbal description of one's positive future

on a worksheet (the language description condition), and imagining one's positive future (the imagery condition). The results of the experiment showed that after the intervention, the scores of the imagery group on the positive and negative affect were statistically and significantly higher and lower, respectively, than those of the language description group. Result indicated that the amount of change in the scores of the positive and negative affect were statistically and significantly larger in the imagery group as compared to the language description group. These results indicate that interventions involving the imagining of one's future via the time machine question of the solution-focused approach have a more direct impact on emotional states than interventions using a language description. This suggests that mental imagery plays an important role in interventions carried out within the framework of the solution-focused approach. The above study is related to the present study because it dealt with mental imagery. It however, differs from the present study because it did not consider analogy problem solving and levels of processing as one of their investigating variables. The study was carried out in the western culture while the present one was carried out in non-western culture like Nigeria.

Several studies (Antonietti et al., 2012; Belanger, 1994; Beveridge et al.,1987; Chamberlain, 2007; Magyari et al., 2020; Mefoh, 2021; Mefoh et al., 2017; Rif'at, 2018; Stuart et al., 2011; Wyra, 2019; Yoon et al., 2004;) show that mental imagery is required for student to perform analogy problem solving.

Levels of processing and analogy problem solving

Nieznański (2020) studied levels of processing effects on context and target recollection for words and pictures using verbal and pictorial materials to test the participants. The results revealed that levels of processing effects were confirmed for context and target recollection when words were used as stimuli. However, reversed levels of processing effects for context recollection were found in experiments using pictures as the to-be-remembered material. The study by Nieznański is related to the present study because it examined the effect levels of processing on context and target recollection task as memory test. However, it differs from it in that it did not consider the mental imagery and its effect on memory test such as analogy problem solving. The study was carried out in the western culture while the present one was carried out in non-western culture like Nigeria.

Other researchers (Ekuni et al., 2011; Loaiza, et al., 2011; Mefoh et al., 2014; Mefoh, 2006; Mefoh, 2010; Patel et al., 2015) indicated that depth processing participants significantly perform better in analogy problem solving compared to shallow processing participants. Much as problem solving is evident in salvaging the society, especially in the school system understanding the role mental imagery and levels of processing play on undergraduate students' problems solving remains paramount and need for further study arises. Also, of all the challenges confronting students' population, problem solving questions is the most challenging.

The above empirical evidence combined to give the study empirical based. The review examined empirical studies by some scholars which are different from and related to the current study as mentioned in the work. Furthermore, some of those studies were done outside Nigeria, and few were undertaken in Nigeria. Moreover, none of those studies addresses effect of mental imagery and levels of processing on analogy problem solving among undergraduates in the Ebonyi State University, Abakaliki. Nigeria. Therefore, the inability of those empirical studies to give more attention to mental imagery and levels of processing it effect on analogy problem solving created a gap in knowledge. It is against this

background that the researcher investigated into mental imagery and levels of processing on analogy problem solving among undergraduates in Ebonyi State University, Ababkaliki. The result of this investigation will fill the gap.

Hypotheses

Following the review of relevant literature, the following hypotheses were tested in this study.

1). Participants who are of high mental imagery would solve the analogy problem better than participants with low mental imagery.

2). Participants with deep level of processing would perform better in analogy problem solving than participants in shallow level of processing.

Method

Participants

One hundred and thirty-eight (N = 138; Male = 69, Female = 69) undergraduate students of Ebonyi State University, Abakaliki (EBSU) participated in the study. The participants were drawn from a population of second and third-year students of the Department of Psychology and Sociological Studies. The participants age ranges from 18 to 30 years ($Mage$ = 22.57, SD = 5.72).

Materials

Three test materials were used for this study. The first material is the Marks (1973) Vividness of visual imagery questionnaire (VVIQ). The vividness of visual imagery questionnaire measures mental imagery ability in terms of vividness and consists of four scenes (relative/friend, rising sun, a shop, a landscape). Each scene is divided into four specific aspects which have to be visualized (e.g., the color and shape of the trees). Participants rated all items on image vividness using a 5-point scale (perfectly clear and vivid as normal vision when I really look at something' to 'no image at all, I only "know" that I am "thinking" about something'). Total scores range from 16 to 80. The mean score on VVIQ is the basis of categorization into the two groups meaning add all the points of each students and the result is divided by 32 to get high and low students. This implies mean score above 32 are high mental imagery and mean score below 32 are low mental imagery. The high scores are those that are above the mean group, and the low score are the students that are below the mean group. High scores indicate high mental imagery or high vividness while low score indicated low mental imagery or low vividness.

Marks (1973) investigated the effects of visual imagery differences on recall of pictures among students and reported good reliability Cronbach's alpha of 0.89. A pilot study to pre-test students VVIQ for Nigerian students was conducted with 120 volunteer undergraduate students (second and third -level) students of the Department of Public administration, Ebonyi State University, Abakalkik. The scale yielded an internal consistency reliability coefficient (Cronbach's alpha) of 0.81, which showed that the instrument has adequate reliability.

Second material used in the study is the attack-dispersion story, where a fortress was located in the center of the country, many roads radiated out from the fortress, a general wanted to capture the fortress with his army. The general wanted to prevent mines on the roads from destroying his army and neighboring villages. As a result, the entire army could not attack the fortress along one road. However, the entire army was needed to capture the fortress, so an attack by one small group would not succeed. The general therefore divided his army into

several small groups. The researcher positioned the small groups at the heads of different roads. The small groups simultaneously converged on the fortress. In this way the army captured the fortress. The attack-dispersion story was used as a training material.

Third material used in the study is the radiation problem which is the main material used to test the student's analogy problem solving. Where a tumor was located in the interior of a patient's body, a doctor wanted to destroy the tumor with rays. The doctor wanted to prevent the rays from destroying healthy tissue. As a result, the high-intensity rays could not be applied to the tumor along one path. However, high-intensity rays were needed to destroy the tumor, so applying one low-intensity ray would not succeed. The doctor therefore divided the rays into several low-intensity rays. The researcher positioned the low-intensity rays at multiple locations around the patient's body. The low-intensity rays simultaneously converged on the tumor. In this way the rays destroyed the tumor. Each correctly step on the radiation problem solving was scored 2 and incorrect step scored 0. The higher the score, the better the analogy problem solving. A pilot study to pre-test the attack-dispersion story (training material) and the radiation problem solving (main test) was conducted with 120 volunteer undergraduate students (second and third -level) students of the Department of Public administration, Ebonyi State University, Abakaliki. The internal consistency for this pre-test study yielded a Cronbach α of .84.

Procedure

At the beginning of the experimental session, participants were informed about the experiment on effects of mental imagery and levels of processing on analogy problem solving among undergraduate students and they were given informed consent form to read and sign indicating their willingness to participate in the experiment. Participants were told that the experiment (which is conducted in their classrooms) is without harm, that they are free to withdraw if they no longer wish to participate, and that information obtained from them will be treated confidentially. Afterwards, participants were assigned into two groups (high mental imagery vs low mental imagery) using vividness of visual imagery questionnaire. The two groups were first presented with attack-dispersion story as a training material. After that, the participants were randomly assigned into two treatment conditions of levels of processing: deep (group A) and shallow (group B) conditions (69 participants each). The participants in deep processing condition (Group A) were moved to experimental Room1 and shallow processing to experimental Room2. Levels of processing were manipulated by varying the instructions that was given to the deep processing and shallow processing conditions.

Participants assigned to the deep processing condition received the following instruction:

"You are welcome to this experiment. When you are seated, you would be given a radiation problem solving story to read. Your task is to state the steps involved in solving the problem as there would be a memory test afterwards. You are to read the problem for 5 minutes''. While

Participants assigned to the shallow processing condition received the following instruction**;**

"You are welcome to this experiment. When you are seated, *you would be given a radiation problem solving story to read. Your task is to carefully study the problem as there would be a memory test afterwards. You are to read the problem for 5 minutes''.*

After studying the stimulus material, five (5) minutes retention interval elapsed before the administration of the analogy problem solving test. Participants were instructed to write their answers on the spaces provided on analogy problem solving test score sheet. The dependent variable was the total correct answer out of the four (4) items on the analogy problem analogy test score sheet. Each correct answer was scored 2, while an incorrect answer was scored 0 (zero).
At the end of the experiment, all the participants and research assistants gathered at experimental Room1. There, they were entertained with a bottle of soft drink and a biscuit. The experimenter took the advantage of the relaxed atmosphere to debrief the participants on the essence of the experiment (APA, 1992), and also, to explain how the participants have contributed in expanding knowledge in research.

Design/Statistics
The design of the study was a 2 x 2 factorial design. The independent variables are 2 levels of mental imagery (High mental imagery Vs Low mental imagery) and 2 levels of processing (Deep processing vs. Shallow process). According to McBurney et al. (2007), factorial design permits researchers to determine if some combination of variables, instead of one acting alone, is responsible for the effect on any of the dependent variables. A 2 way- analysis of variance (ANOVA) was the statistic used to test the stated hypothesis and SPSS Version 25 aided the analysis.

Results
Table 1: Mean and Standard Deviation of Effects of Mental imagery and Levels of Processing on Analogy Problem Solving.

Variables	levels	Mean	SD	N
Mental Imagery	High	8.44	4.12	69
	Low	10.53	5.08	69
Levels of processing	Deep	12.97	6.59	69
	Shallow	6.96	3.15	69

Table 1 indicated that participants with high mental imagery had lower analogy problem solving mean score (*M* = 8.44*, SD* = 4.12) when compared with low mental imagery with higher mean score (*M* = 10.53*, SD = 5.08*) on analogy problem solving. Also, participants in the deep processing group had a higher analogy problem solving mean score (*M* = 12.97*, SD* = 6.59) than those in the shallow processing group with lower mean score (*M* = 6.96, *SD* = 3.15).

Table 2. Summary of ANOVA of effects of mental imagery and levels of processing on Analogy Problem Solving among Undergraduate Students.

Variables	SS	DF	MS	F	P	ES
Ment. Imagery	8.86	1	8.86	6.93*	<.04	0.29
LOP	121.92	1	12.99	10.65*	<.03	0.73
A x B	8.03	1	8.03	6.28*	<.035	0.38
Error	164.	134	1.48			

Total	2362.10	137	24.83

Note: *p<.05; ES = Effect Size, Mental Imagery were coded as High = 1 and Low = 0, Levels of Processing were coded as deep = 1, Shallow =0

Table 1 showed that the mean score difference between participants who possessed the high mental imagery and others who utilized the low mental imagery on analogy problem solving was significant, $F(1, 134) = 6.93$, $P<.05$, $ES = 0.29$. Also, participants who used the high mental imagery showed superior analogy problem-solving ability than participants who used the low mental imagery on analogy problem solving. Regarding levels of processing, the mean score difference between deep and shallow participants on analogy problem solving was also significant, $F(1, 134) = 10.85$, $P<.05$, $ES = 0.73$.

Deep level processing participants seem to have higher analogy problem solving ability than shallow participants. The results also revealed a significant interaction effect between mental imagery and levels of processing, $F(1, 134) = 6.28$, $P< 0.05$, $ES = 0.38$.

Discussion

Effects of mental imagery and levels of processing on analogy problem solving among undergraduates were examined in this current research. The current research tested two hypotheses. The first examined whether participants who possessed high mental imagery would solve analogy problem better than participants with low mental imagery. The hypothesis was accepted and confirmed that participants who possessed high mental imagery statistically and significantly solved more analogy problem than participants characterized by low mental imagery. This finding supports previous related literature (Antonietti et al., 2012; Mefoh. 2009; Rif'at, 2018; Stuart et al., 2011; Wyra, 2019;), which found that participants who use high mental imagery, because they use active visual pattern, tend to be more focus on analogy problem solving compared to people with low mental imagery. The difference in performance on analog problem solving between high mental imagery and low mental imagery should be understood in reference to the quasi-pictorial theory of mental imagery (Kosslyn, 1994; Marr's, 1982; Pinker, 1988).

The theories characterized the mental imagery students as those who pay attention to visual information processing, greater problem-solving ability such as analogy problems, thinking, creativity and decision making among undergraduate students. These resources put students with the high mental imagery at advantage over students with the low mental imagery on analogy problem solving. (Memory task). The theories described the low mental imagery students as those who "seem to be inactive in problem solving task" (Mark, 1973).

The second hypothesis of the study that stated participants in deep levels of processing will perform better than participants in shallow level of processing on analogy problem solving among undergraduate students. The hypothesis was accepted and supported by (Mefoh, et al., 2014; Mefoh, 2010; Nieznański, 2020; Patel et al., 2015) in their studies found that deep participants perform better in analogy problem solving when compared to shallow participants. The present finding is also consistent with previous empirical research findings (e.g., Barton, 2010; Giraldo, 2013; Mefoh, 2006; Rose et al., 2012; Samavi et al., 2013) showing that deep processing leads to superior performance on problem solving because semantic processing involves thinking about the memory task in a conceptual way and there is increased levels of stimulus elaboration. The difference in performance on analog problem solving

between deep participants and shallow participants should be understood in reference to (Craik et al., 1972) levels of processing framework, memory tasks that require participants to consider the semantic features of the material needed a deeper processing and resulted in greater problem-solving task. The theories described the deep processing students as those who "seem to be processes information through concentration, pay more attention and focus on problem solving task than shallow processing participants (Craik et al., 1972).

An incidental finding in the analysis was the interaction effect observed between mental imagery and levels of processing. The results are instructive, as mentioned by Mefoh (2010) that when interaction is exist, it does not make sense to discuss the effect of each independent factors separately. Therefore, the combined effect of mental imagery and levels of processing on analogy problem solving which implies that neither of the two factors (mental imagery and levels of processing) had a simple independent effect on analogy problem-solving ability. The interaction demonstrates that whether deep participants would solve more analogy problem solving than shallow participants depend on the kind of levels of processing dimension that the subjects possessed. When student possess the deep processing, they tend to have superior analogy problem-solving ability than shallow participants.

Implications of the Study

The present study has both theoretical and practical implications. Achievement in this is vital in the society today in enhancing memory task, mental imagery abilities, and levels of information processing. Knowing category of mental imagery was significant with analogy problem solving. This finding implies that undergraduate students who processed high mental imagery, easily make out meaning from difficult situations and have ability of solving problems in the society. This category of people like to make decisions by analysing them and always concerned with solving rational problems that benefits the society. Their perceptive ability is always shown to be related to capability of complexity, flexibility, and imagination while engaged in daily tasks. With their understanding of changes in the society, they constantly imagine possible better opportunities that will solve problems. Undergraduate students who display these attributes at university should be identified by school managements, and properly guided on the best ways to develop their problem solving skills as they can contribute meaningfully to the society.

Furthermore, this study has important implication for education. Studies (e.g., Mefoh, 2009 ; Wyra, 2019) indicated that high mental imagery positively and significantly affect students overall problem-solving task compared to low mental imagery student's participants. Therefore, undergraduate's students, pupils and other higher learners should be encouraged and supported to learn the mental imagery processes of problem solving irrespective of whether the student uses high mental imagery or low mental imagery in problem solving task. Students with the high mental imagery are high active than low mental imagery students in terms of analogy problem solving ability.

Levels of processing (deep) was significant to analogy problem solving. This has theoretical. Deep levels of processing are identified as a potential factor that propels undergraduate students to engage in problem solving tasks despite the complexity or challenges in our society today. This gives credence to existing postulations of levels of processing theory (Craik et al., 1972) stated that, memory tasks that require participants to consider the

semantic features of the material needed a deeper processing and resulted in greater problem-solving task. This finding showed that participants with deep levels of processing are more likely to provide ground breaking solutions to societal problems. This may be because deep processing led to better understanding, comprehension, concentration and pay attention to a particular memory task that result to problem solving in our society.

Also, studies (Mefoh et al., 2014; Mefoh, 2010) showed that the deep processing positively influence students' overall problem-solving task compared to the shallow processing students. Therefore, students, pupils and other learners should be motivated and aided to learn the processes of information irrespective of whether the learner uses deep or shallow in problem solving. Students with the deep processing are high successfully than shallow processing students in terms of problem-solving ability.

Limitation of the Study

This experimental study has some limitations. First, the generalizability of the findings of this study may be limited to university undergraduate students. In addition, only the undergraduate students of Psychology and Sociological Studies, Ebonyi State, Abakaliki were sampled in the study. Therefore, no comparison was made between these students and students in other department/higher institutions at other locations within Nigeria.

Suggestions for Further Study

The experimenter makes the following suggestions for further Study. Other researcher should consider using participants from more than one university, and increase the number of participants for the study.

Furthermore, in testing for, effort should be made in ensuring that participant completed Vividness of Visual Imagery Questionnaire. In addition, it is suggested that further research may involve other variables like reinforcement, handedness, age gender, association and algorism problem solving,

Conclusion

Students use analogy problem solving ability to tackle complex problems quickly, to save time. The present study investigated how mental imagery and levels of processing influence this process. Analysis of data revealed that high mental imagery participants showed higher task performance on analogy problem solving compared to low mental imagery participants; and deep processing participants showed superior performance on problem solving compared to participants in shallow processing on problem solving task. Also, combined effect (interaction) of mental imagery and levels of processing on analogy problem solving ability. In educational environments and other learning institutions, use of the high mental imagery and deep levels of processing should be encouraged.

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