

## Chapter 2

### **Improvement of Senior Secondary School Students’ Achievement in Physics in Ekiti State Through Mind Mapping-Based and Visual Imagery Instructional Strategies**

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#### **Abstract**

The study examined the Improvement of Senior Secondary School Students’ Achievement in Physics in Ekiti State Through Mind Mapping-Based and Visual Imagery Instructional Strategies. Jerome Brunner’s Theory of Discovery Learning and Paivo’s Theory of Dual Code were adopted as the framework, while the pretest–posttest control group quasi-experimental design Six public secondary schools (two per LGA) were purposively. Intact classes of senior secondary II physics students were utilized. The instruments used were Physics Achievement Test, Training manual for MMbS strategy, Training manual for VIS strategy. Instructional Guide for the Conventional Method. Data collected were analyzed using Analysis of covariance, estimated marginal means, bar chart and Bonferroni post-hoc test. The main effect of treatment was significant on students’ achievement. The participants in VIS treatment group had highest post-achievement mean score in physics followed by MMbS and the control groups. Visual imagery and mind mapping-based strategies enhanced senior secondary school students’ achievement in physics in Ekiti State, Nigeria. Both strategies should be adopted by physics teachers to enhance achievement in physics.

*Keywords:* Mind mapping-based, Visual imagery, strategy, Improvement, Achievement, Physics.

#### **Introduction**

The word science is derived from the Latin word *scire*, meaning “to know”. The significant advancements in fields like communication, agriculture, and technology that have propelled national development can be attributed to scientific innovations (Adodo, 2013). Branches of science include biology, chemistry and physics at the senior secondary school level (Federal Ministry of Education, 2014). Furthermore, among all the branches of science previously stated, physics takes a centre-stage in the development of technology and very essential and suitable for modern age of science and technology (Fasakin, 2011; Ukoh and Amuda, 2015).

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The teaching of physics commenced in mission and government secondary schools in Nigeria before she got her independence in 1960 (Adeyemo, 2010). The objectives of teaching physics at this senior secondary school level, among others include providing basic literacy in physics for functional living (Federal Ministry of Education, 2014).

Despite the significance of Physics to mankind and the endeavour of researchers (Ukoh, 2013; Asubiojo, 2015) to enhance on its instructional and learning aspects, achievement of students in the subject continues to vary in Ekiti state.

Table 1: Performance of Students in Physics in West African Senior School Certificate Examination 2010-2019 in Ekiti State, Nigeria.

Year	No of candidates	A1-B3 %	C4-C6 %	Credit (1-6) %	Pass (7-8) %	Fail (9) %	Total failure (7-9) %
2010	5765	13.80	36.42	49.77	31.66	13.30	44.95
2011	7317	18.28	65.05	83.31	9.08	1.44	10.51
2012	5155	16.45	51.72	68.17	22.87	7.53	30.40
2013	4964	13.40	42.89	56.29	28.22	13.65	41.88
2014	5862	14.00	41.61	55.61	29.56	14.82	44.39
2015	6069	16.10	34.37	47.17	33.37	19.46	52.83
2016	5231	31.49	48.29	79.77	12.83	7.40	20.33
2017	5250	8.59	43.30	51.89	34.65	13.47	48.11
2018	4989	40.17	46.46	86.63	6.84	6.53	13.37
2019	6753	24.25	43.27	67.53	18.97	13.50	32.47
2020	5183	53.27	40.63	93.90	3.65	2.45	6.10
2021	6272	61.32	26.85	88.67	3.41	8.42	11.85

Source: Planning, Research and Statistics Department, Ministry of Education, Science and Technology, Ado-Ekiti, Ekiti State, Nigeria.

Table 1 above highlights the variation in the academic performance of students from 2010 to 2021. In 2010 only 49.77% were able to make the required credit pass while 44.95% got either D7, E8 or F9 which cannot get them admission into tertiary institutions. In year 2011, an improvement was recorded where 83.31% were able to make the required credit pass while 10.51% could not. However, between 2012 and 2015, the performance went down to 30.40% in 2012, 41.88% in 2013, 41.88% in 2014 to 52.82 in 2015. This was then followed by a reduced cumulative failure rate of 20.33% in 2016. Again in 2017, the cumulative failure percentage increased to 48.11% while only 51.89% were able to make the required credit pass. However,

in 2018, the failure rate reduced to 13.37% passed at the required level though it is still leaving room for more improvement. This fluctuating performance has negative impact on students who wish to study Physics and various Physics-related disciplines at a more advanced educational level. This is due to the requirement of attaining a credit pass or higher, which signifies a strong fundamental understanding of Physics, before progressing to tertiary institutions to study Physics-related subjects that contribute to technological advancements on a global scale.

These not-too-good performances are also traceable to the nature of Physics such as abstractness, wideness and complexities. Therefore, there is need for concretization of its abstractness in form of pictures, simplification and conciseness of the wideness of Physics. All these are essential features of mind mapping and instructional strategies that involve visual imagery. Goldberg (2004) described mind mapping as a visual thinking tool invented by Tony Buzan in the early 1970s while Upasa (2017) defined visual imagery as the ability to create mental pictures while reading or learning which plays an important role in both the understanding, memorability and retention of concepts.

### **Statement of the Problem**

Physics is being referred to as the bedrock for technological advancement. The analysis of performances between 2010 and 2021 in physics in SSCE are inconsistent. These have been a concern to educational stakeholders. Several reasons have been advanced but not limited to voluminous nature of the curriculum of physics, abstractness of the subject, teacher-centered teaching methods. Towards solving this problem, researchers in the field have suggested and worked on various teaching strategies such as drill and practice instructional strategy, computer based learning, computer simulated learning, active reading, brainstorming, circle the sage, categorizing, concept attainment, concept mapping, webbing, concept formation, cubing, explicit teaching, graphic organizers, head together, heterogeneous grouping, homogenous grouping, jigsaw, know what to learn (KWL), modeling, peer partner learning and peer tutoring. Despite all these efforts, students' achievement has not improved as expected over time. However, due to the nature of the strategies stated earlier, which are not allowing students to create mental pictures of the concept, the MMbS and VIS strategies are two strategies that allow students to create these mental pictures of the concept taught in class as they stimulate and enhance curiosity, creativity, connectivity, concretization of abstractness. Therefore, this study was carried out to assess the effects of Mind Mapping-based Strategy and Visual Imagery Strategies on senior secondary school Students Achievement in Physics

### **Hypotheses**

The underlisted hypotheses were formulated and tested at 0.05 level of significance:

**Ho1:** There is no significant main effect of treatment on learners' achievement in physics

**Ho2:** There is no significant difference in mean scores of learners' post-achievement in physics based on treatment

## **Literature Review**

Studies had uncovered different significance of VIS, useful in imagination and productive in memory improvement since it works with information processing when errand is unique; effective in critical thinking (Singn and Pande, 2003, 2010). Roell (2019) noted that the incorporation of visual aids in educational settings has led to heightened student engagement and improved retention of information. The utilization of images in the classroom can enhance learners' visual literacy skills, hence fostering their critical thinking capabilities and lifelong learning aptitude. Based on the research conducted by Murphy, Nordin, and Cumming (2006), Pierre and Alain (2010), Singh and Pande (2017), Upasa (2017), Roell (2019), Aladejana and Olusola (2021), and Ukoh and Aladejana (2022), it has been determined that the aforementioned technique holds promise for use in the field of physics education. Researchers led a semi trial study with a conventional group, including a pre-test, a post-test, and a conventional group, to investigate the effect of VIS and MMbS instructional philosophies on the numerical capacities of senior optional school learners in Ekiti State, with an emphasis on numerical mechanics. The study involved 246 learners from a few schools majoring in physics. The researchers (Aladejana and Olusola, 2021) saw that the treatments essentially affected the learners' math capacity.

MMbS studies have been directed with an extensive variety old enough group. Positive and adverse results have happened, and each research has added to the improvement of education. The instructor can assess learners' learning using a few MMbS procedures. Farrand, Hussain, and Hennessy (2002) assessed the effect of mind mapping on second- and third-year clinical learners who were reading Logical American. Two groups were shaped: a self-chose study group and a mind mapping group. Oneself chose study group could utilize any study of their decision. The MMbS group was given instructions on the best way to apply the methodology and was committed to do as such. They found that MMbS was an incredibly productive strategy for learning composed content.

Adodo (2013) investigated the effect of using mind mapping as a self-managed learning approach on learners' scholastic execution in fundamental science and innovation courses. The inquiry utilized a semi trial research plan. A sum of 120 learners partook in the continuing research try. All members were picked at random from three unique public, non-isolated schools. A sum of sixty learners was doled out to each group using the ordinary random choice technique. Then, a separated random sampling strategy was utilized to pick thirty male and thirty female learners from each group. The study's findings show that the treatment impacts the learners' presentation. This end was plainly settled using numerous classification investigation on attainment and maintenance. The study uncovered that students who were presented to MMbS had an impressively higher mean score on the change post-test than their cohorts in customary groups. The study presumed that using MMbS as a part of an educational methodology further developed students' achievement scores, knowledge procurement, and information maintenance.

## **Research Design**

The study used a pretest-posttest conventional group quasi-experimental design.

### **Selection of Participants**

The population for the study comprised all Senior Secondary Schools II learners offering Physics in Ekiti state. A random selection was made of three (3) Local Government Areas from the three senatorial districts that make up Ekiti State. A total of six schools were chosen, with two schools intentionally selected from each LGA.

### **Research Instrument**

Four research instruments were used for the study (stimulus and response); they are: Physics Achievement Test (PAT), training manual for MMbS strategy, training manual for VIS strategy, Instructional Guide for the Conventional Method

### **Methods of Data Analysis**

Following the collection of data, descriptive statistics (mean, percentage, and standard deviation) were utilised in order to examine the data. Furthermore, inferential statistics such as analysis of covariance (ANCOVA) were utilised in order to ascertain the main and main interaction effects that were determined to be significant on the variables that were investigated in this study. It was determined that the performance of each group was determined by using estimated marginal means, also known as EMMs.

### **Results and Discussion**

Table 2: Analysis of Covariance (ANCOVA) of Post-Achievement by Treatment

Source	Type III SS	df	MS	F	Sig.	Partial Squared	Eta
Corrected Model	1355.761	17	79.751	5.104	0.000	0.430	
Intercept	1832.675	1	1832.675	117.280	0.000	0.505	
Pre Achievement	106.628	1	106.628	6.824	0.010	0.056	
Treatment	485.200	2	242.600	15.525	0.000*	0.213	
Error	1797.051	115	15.627				
Total	26496.000	133					
Corrected Total	3152.812	132					

R Squared = 0.43 (Adjusted R Squared = 0.35) \* denotes significant  $p < 0.05$

According to the findings displayed in Table 2, it was observed that there was a significant main effect of treatment on students' achievement in physics ( $F_{(2, 131)} = 15.53$ ;  $p < 0.05$ , partial  $\eta^2 = 0.21$ ). Table 4.1 indicated the effect size of 21.3%, implying that 21.0% of the total 35.0% (Adjusted  $R^2 = 0.35$ ) variation in students' post-achievement scores in physics in this ANCOVA model was due to the significant main effect of the treatment on students' achievement in physics. Therefore, hypothesis 1a was not accepted

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**Ho2:** There is no significant difference in mean scores of learners' post-achievement in physics based on treatment

Table 3: EMM for Post-Achievement by Treatment and Conventional groups

Treatment	X	SD	95% Confidence Interval	
			Lower Bound	Upper Bound
MMbS	14.57	0.95	12.69	16.44
VIS	17.70	0.84	16.03	19.37
Conventional Strategy (CS)	9.47	0.97	7.55	11.40

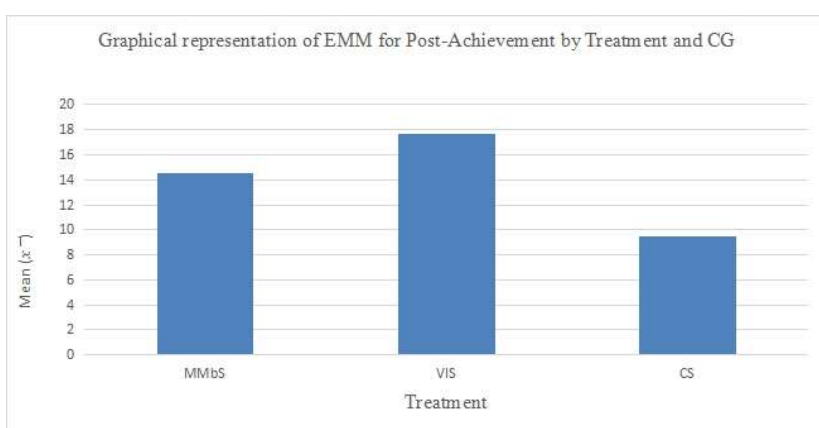


Figure 1: Graphical representation of EMM for Post-Achievement by Treatment and CG

Table 4.6 revealed that students exposed to the Visual Imagery Strategy (VIS) treatment group 2 had highest adjusted mean score in their post-achievement in physics (17.70) followed by those taught by the MMbS treatment group 1 (14.57) and the Conventional Strategy (CS) control group (9.47). This order is represented VIS > MMbS > CS. To find which of the groups caused this significant main effect of treatment on students' achievement in physics, the Bonferroni post-hoc test was carried out across the groups, while the result is presented in Table 4

Table 4: Bonferroni Post-hoc Analysis of Post-Achievement by Treatment and Conventional groups

(I) Treatment	(J) Treatment	X Difference (I-J)	Sig.
MMbS	VIS	-3.131*	.046
	Conventional Strategy (CS)	5.091*	.001
VIS	MMbS	3.131*	.046

	Conventional Strategy (CS)	8.222*	.000
Conventional Strategy (CS)	MMbS	-5.091*	.001
	VIS	-8.222*	.000

Table 4 indicated that the post-achievement mean score in physics of learners in the Visual Imagery Strategy (VIS) was significantly different from those taught by Mind Mapping-based (MMbS) and the CS, respectively. Table 4 also indicated that the difference in the post-achievement mean scores of learners exposed to MMbS and their counterparts in the CS was significant. This implies that the significant difference indicated by the ANCOVA result was due to the difference between the TG (visual imagery strategy and MMbS) and also between the treatment and the control groups.

### **Discussion of Findings**

The result showed significant main effect of treatment on learners' achievement in physics. Students exposed to the Visual Imagery Strategy TG had highest adjusted mean score in their post-achievement in physics followed by taught with the MMbS treatment group and the CS control group. This order is represented  $VIS > MMbS > CS$ . The efficacy of the two strategies may be linked to the students' active participations,

Also, the results indicated that the post-achievement mean score in physics of learners in the Visual Imagery Strategy (VIS) was significantly different from those taught with Mind Mapping-based (MMbS) and the Conventional (CS) strategies, respectively. The result also indicated that the difference in the post-achievement mean scores of students exposed to MMbS and their counterparts in the CS was significant. This means that the significant difference indicated by the ANCOVA result was due to the difference between the treatment groups (visual imagery and mind mapping-based strategies) and also between the TGs and the CG. The effectiveness of the mind mapping-based and visual imagery instructional strategies over the conventional instructional strategy in improving learners' achievement scores in physics could be attributed to the fact that both strategies allow students to create pictures when learning. The use of these images in the classroom has led to increased students' interactivity and assist them to retain information in their memory. Teaching with images also help to develop students' visual literacy skills, which contributes to their overall increment in the achievement and lifelong learning. The result of the efficiency of visual imagery and mind mapping-based strategies over conventional strategy is in support of dual code theory of learning, put forward by Paivo in 1971, that teachers should help learners to create pictures through visual and language information. Teachers as facilitators should assist learners utilizes diverse stimuli to aid the students to encode information very well which assist it to be recalled later.

The effectiveness of the visual imagery could be attributed to its ability in making learners to create mental pictures while learning which consequentially assist in the understanding, memorability and retention of the concepts being learnt.

Also, the result of the efficacy of the visual imagery supports the finding of Syamsu et.al. (2020) that the utilization of Visual Imagery Strategy is effective in increasing students' reading comprehension. The effectiveness of visual imagery strategy is also in line with the finding Küssner and Eerola (2019) who reported that VI is a crucial part of the listening experience and listener's emotion. Similarly, the result supports the finding of Singh and Pande (2017) who reported that visual imagery has crucial position in almost all cognitive processes and operations. Furthermore, the result is in support of the finding of Zahedi and Abdi (2012) who discovered that memory strategy instruction improves achievement in vocabulary learning of the learners. The result also lends credence to the finding of Nemati (2009) that the learners of visual imagery strategy group performed both in short-term and long-term scores better, and they are superior in memory strategies in long-term and short-term retention. The result of the efficacy of visual imagery strategy complements the finding of Noordin (2004) that visual imagery strategy produced significant main effect on students' reading comprehension achievement, as compared to conventional strategy. However, the result of the finding contradicts the findings of Sullivan (2006) which revealed that no significant advantageous treatment effects of VIS when used to teach mathematics.

### **Conclusion**

Visual imaging and MMbS tactics had an impact on students' accomplishment in physics when compared to the standard way, according to the findings of the study. Additionally, the conventional method had no impact.

### **Recommendations**

The following suggestions are consequently offered in light of the findings of this study, which are as follows:

(i) In order to increase students' performance in physics, teachers should implement tactics that are based on MMbS and VIS when teaching mechanics in the subject of physics.

(iii) Curriculum planners could also benefit from calling attention to the fact that whenever the MMbS and VIS tactics are to be utilized, there should be the incorporation of activities that will transform what forms in the minds of learners into practice.

(iv) The government should conduct training and re-training programmes for in-service teachers on the efficient utilization of MMbS and visual imaging tactics. These programmes should be organized through the organization of seminars, workshops, and conferences for physics teachers working at secondary school levels. In order to successfully and adequately implement these tactics in the teaching of physics, this would be of great assistance to them.

### **DECLARATION**

The authors declare that this manuscript have not been published or submitted for publication elsewhere

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