International Journal of Early Childhood Special Education (INT-JECSE)
DOI:10.48047/intjecse/v16i4.71 ISSN: 1308-5581 Vol 16, Issue 04 2024

Effects of Mind Mapping-Based and Visual Imagery Instructional Strategies on Senior Secondary School Students' Practical Skills in Science in Ekiti State, Nigeria

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Abstract
The study investigated the effects of mind mapping-based and visual imagery instructional strategies on senior secondary schools students' practical skills in science in Ekiti state, Nigeria. This study adopted a pre-test post-test quasi experimental control group design. The sample for this study was one hundred and thirty three (133) students chosen from six (6) senior secondary schools from three Local Government Areas across the three senatorial districts that made up the state through purposive sampling technique. Science Practical Skills Test (SPST) was used for the collection of data for the study. Analysis of Covariance (ANCOVA), Estimated Marginal Means (EMM) and Bar Charts were used to analyze the data obtained at significant level of 0.05. The findings of this study revealed that there was no significant effects of the strategies on students' practical skills in science. Based on the findings, appropriate conclusion and recommendations were made.
Keywords: Mind Mapping, Mind Mapping-Based, Visual Imagery, Instructional Strategies, Practical Skills.

Introduction

The English word "science" stems from the Latin verb "scire," which translates to "to know." The field of science has made great progress since its modest beginnings, emerging as one of the most important and influential areas of human pursuit. Currently, numerous subfields within the realm of science investigate a wide range of phenomena that are observable or detectable (Fasakin, 2011). The entirety of scientific inquiry significantly shapes human understanding of the universe, celestial bodies, their own existence, and other forms of life. Adodo (2013) asserts that the significant advancements in communication, agriculture, and technology, which have contributed to national development, can be attributed to the innovations generated within the scientific community. According to Raymond (2010), scientific information was acquired solely for its intrinsic value and lacked practical utility.

The onset of the industrial revolution throughout the 18th century, conversely, instigated a multitude of noteworthy transformations. Science has a profound impact on people's lives in the modern era, primarily through technology. Technology refers to the use of scientific knowledge for practical purposes. In Olagunju, Adesoji, Iroegbu & Ige (2003) assertion, science plays a pivotal role in the development of microcomputers and other innovative applications, hence facilitating industrialized nations in attaining unparalleled levels of national prosperity, military prowess, and an esteemed national standing. As per the Federal Ministry of Education (2014), the Senior Secondary School (SSS) level encompasses the academic fields of biology, chemistry, and physics under the realm of science.

However, WAEC Chief Examiners' reports (2015, 2016, 2017, 2018, 2019, 2020) revealed learners' weaknesses in science practical as they show inability to record observations properly, inconsistencies in the recording of parameters, using wrong units, poor computational and drawing skills, use of odd scales for plotting graph points, inability to plot the graph points correctly to accuracy, and to make deductions from graphs plotted. In order to solve the problems highlighted, WAEC Chief Examiners suggested that teachers should as a matter of urgency expose learners early to practical and take them through practical work frequently in order to acquire basic practical skills. Knowing fully well that 40% of total marks are allotted to science subject practical alone, which means, if learners could do well in practical, he/she has a chance of getting minimum credit pass which is the least score (grade) required to pursue career in science or science related courses. According to Usmani (2011), learners who have a greater amount of practical experience are more likely to do better in science experiments than those who have fewer practical abilities. These experiments give opportunities for the applications of students' theoretical knowledge into practice and connect theory and practice.

The conventional method of teaching science and it is reported as the primary cause of lack of practical skills (WAEC Chief Examiner Report, 2015-2019, Linsday, 2011; Ukoh, 2013; Vincent and Akpan, 2014 and Giriharam and Raju, 2016 because this method does not encourage students' participation during lesson. It only encourages verbal presentation of ideas, facts, concepts and generalization such that learners are provided with facts or information which makes them remain passive and obtain information from their teachers and is no longer sufficient to prepare students to survive in today's world(Vincent and Akpan, 2014). However, to improve the acquisition of Students' Practical Skills in Science (SPSiS) as a result of consistent usage of conventional method, Asubiojo (2015) suggested that new innovative instructional strategies should be incorporated because sciences education will remain similar to that practiced in the 1950s with the conventional lecture method. Based on the findings of several studies conducted by Buzan (2000), Okeke (2012), Adodo (2013), Rahmah (2017), Vijayavalsalam (2019), Adewumi (2021), it has been demonstrated that mind-mapping has been widely accepted as a successful and viable method for instruction. The results of these studies suggest that learners who get instruction using MMbS have notably greater levels of achievement in terms of conceptual understanding and practical reasoning in comparison to those who are taught using the conventional approach. Biktimirov & Nilson (2006) asserted that MMbS, alternatively referred to as thought mapping, is a technique that entails the visual arrangement and non-linear depiction of thoughts and their interconnections.

Similarly, Burmark (2002), as cited in Bozdogan (2011), posited that educators can employ instructionally induced Visual Instructional Strategy (VIS) to augment the educational experience and foster a rapport between instructors and learners. VIS, as defined by Seo-Hyun, Minji & Seong-Whan (2002), is a fundamental category of imagery that encompasses graphics, visual scenes, photographs, and the sight sense. The emergence of the visual picture is sometimes referred to as an intuitive brain-computer interaction paradigm. In a similar manner, Upasa (2017) provided a description of visual imaging as the cognitive ability to create mental representations throughout the process of reading or learning. This cognitive activity has a crucial role in enhancing the understanding, retention, and memorization of information.

More so, Rahmah (2017) examined the effectiveness of using mind mapping strategy on students writing skill in descriptive text. They adopted quasi-experimental research design. Fifty two participants were drawn from eighth grade of Negeri 1 Kota Tangerang Selatan. He found out that there was a positive effect of the strategy on students' descriptive text writing skills. Furthermore, in his work, Vijayavalsalam (2019) examined mind mapping strategy for enhancing writing skills. The sample of his research included 151 students enrolled in General Education Program at Abu Dhabi University. The age of the participants for the study was between 18 and 23 years. He used structured questionnaire to collect the required data for this study. More so, he used Chi-square one way ANOVA and Correlation to analyse the data collected. The results of his research work revealed that the Chi-Square value for mind maps before essay writing and mind maps develop thinking skills

while essay writing was 57.27, and this value was significant at the five percent level which means that mind mapping strategy enhanced the thinking capabilities of students.

He equally enthused further that the mind mapping strategy is an excellent and innovative strategy which enables learners to discover new ideas for essays, assignments, etc., in a very limited time; helps in improving the quality of essays and aids students to enhance their writing skills in a given time frame; assist in comprehending a particular topic assigned for essay writing in a better way by focusing on ideas written down in one's own words and observing connections between them. He finally submitted that mind mapping as a strategy is useful in both situations, i.e. before essay writing and during essay writing. In the above study, it was found that those students of Abu Dhabi University who used mind maps showed improvement in their writing capabilities and quality of writing. Hijazi (2015), examined effect of using mind map on the level of practical skills, according to learning style of 46 second year female learners of the faculty of physical education, Sadat city university for academic year 2013/2014 verbal intelligent test and VARK test were used to collect the data. The result of the study revealed mind mapping has not significant effect on the student skills performance (practical skills) through learning style.

Science subjects which play significant role in innovations and technological advancement of any nation. Learning science promotes students' creative and problem solving abilities. Furthermore, one of the goals of teaching science in secondary schools is for students to acquire essential basic literacy in science for functional living; acquire essential scientific skills as a preparation for technological application and to develop ability to recognize problems and solve them.

However, reports show that very few students actually acquire substantial sufficient practical skills in science. These have been attributed majorly to the use of conventional method which spoon-feed learners and makes them passive. Some scholars have suggested that strategies which enable students to learn in form of pictures should be adopted in a bid to improve acquisition of practical skills in science, two of such are mind mapping-based and visual imagery instructional strategies. While mind mapping and visual imagery instructional strategies have been shown to improve students' learning outcomes in art and commercial subjects, there isnot much research on their uses in the area of acquisition of practical skills among science students. Hence, this study examined the effects of mind mapping-based and visual imagery strategies on practical skills of SSS students in science in Ekiti State, Nigeria.

Research Hypotheses

The following two hypotheses were tested at 0.05 level of significance:

Ho1: There is no significant main effect of treatment on learners' Practical skills in science

Ho2: There is no significant mean difference in the performance of learners exposed to MMbS, VIS and CS.

Research Design

The study adopted a pretest-posttest control group quasi experimental design.

Population and Sampling Techniques

The population comprised all learners offering science subjects in all the Senior Secondary Schools in Ekiti State. Purposive sampling techniques was used to choose two schools from each of three senatorial districts in the state making six schools.

Research Instruments

The research instruments were used for the study were Science Practical Test, Instructional Guide for mind mapping strategy (IGMMS); Instructional Guide for visual imagery strategy(IGVIS); Instructional Guide for conventional (IGCS) and Evaluation Sheets for Assessing Teachers Performance on the use of the strategies (ESATP):

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 and bar chart.

Results and Discussion

Ho1: There is no significant main effect of treatment on students' practical skills in science

Table 1: Analysis of Covariance (ANCOVA) of Post-Practical skills by Treatment, Gender and Learning styles

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	654.121	17	38.478	1.743	0.045	0.205
Intercept	2092.042	1	2092.042	94.763	0.000	0.452
Pre-Practical skills	83.694	1	83.694	3.791	0.054	0.032
Treatment	45.432	2	22.716	1.029	0.361	0.018
Treatment x Gender	50.999	2	25.500	1.155	0.319	0.020
Treatment x Learning style	23.482	4	5.870	0.266	0.899	0.009
Gender x Learning style	62.507	2	31.253	1.416	0.247	0.024
Treatment x Gender x Learning style	39.311	4	9.828	0.594	0.620	0.015
Error	2538.812	115	22.077			
Total	70232.000	133				
Corrected Total	3192.932	132				

R Squared = 0.21 (Adjusted R Squared = 0.09) * denotes significant $p<0.05$

Table 1 showed that the main effect of treatment on students' practical skills in science was not significant ($F_{(2, 131)} = 1.03$; $p>0.05$, partial $\eta^2 = 0.02$). Hence, hypothesis 1 was not rejected. This means that treatment had no effect on students' practical skills in science. Although there was no significant difference across treatment groups, the EMM of the TGs was carried out in order to establish the performance across the groups.

Ho2: There is no significant mean difference in the performance of learners exposed to MMbS, VIS and CG

Table 2: EMM for Post-Practical Skills by Treatment and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Mind Mapping-based Strategy (MMbS)	20.82	1.19	18.46	23.17
Visual Imagery Strategy (VIS)	22.95	1.09	20.79	25.11
Conventional Strategy (CS)	22.17	1.27	19.65	24.69

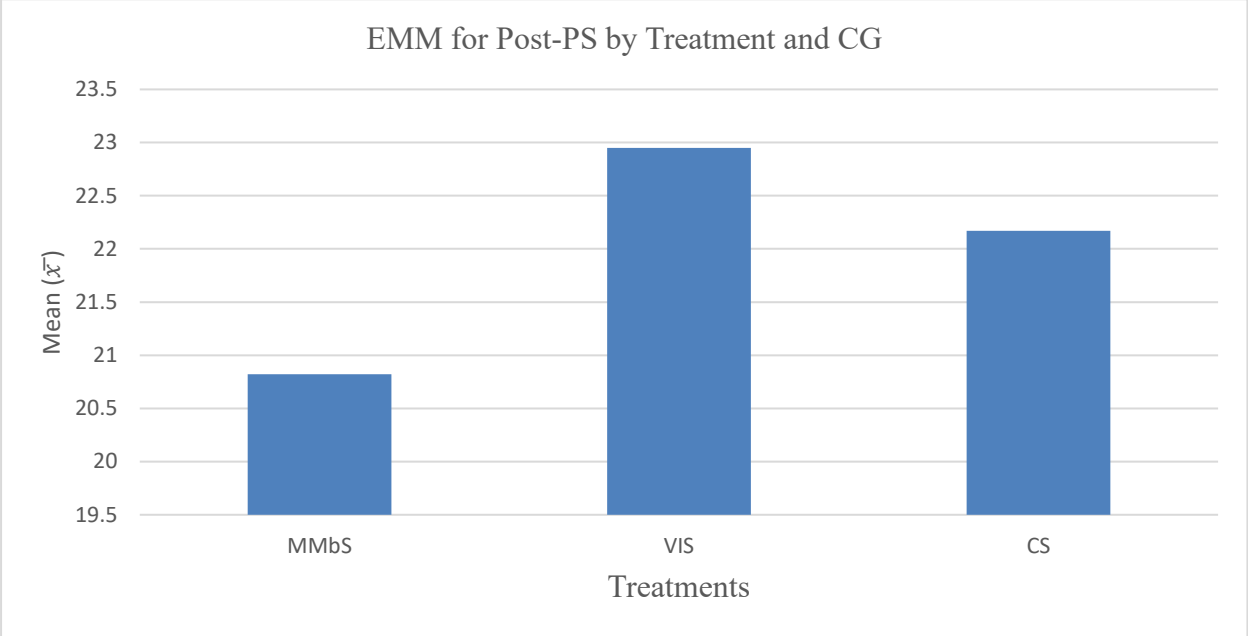

Figure 1: A bar chart showing EMM for Post-PS by treatment and CG

Table 2 revealed that learners exposed to the Visual Imagery Strategy (VIS) TG had highest adjusted post-practical skills mean score in science (22.95) followed by Conventional Strategy (CS) control group (22.17) and Mind Mapping-based Strategy (MMbS) treatment group 1 (20.82).

Discussion

The finding revealed that the main effect of treatment on learners' practical skills in science was not significant. This means that treatment had no effect on students' practical skills in science. Although there was no significant difference across TGs, the EMM of the TGs was executed in order to establish the performance across the groups and the result showed that the learners exposed to the Visual Imagery Strategy TG had highest adjusted post-practical skills mean score in science followed by Conventional Strategy (CS) control group and Mind Mapping-based Strategy (MMbS) treatment group 1. This difference is not statistically significant. This finding means that practical skills was not sensitive to the mind mapping strategy and thereby could not able to cause an effect on students' practical skills in science. This might be due to the fact that it aids more of cognitive domain and less of psychomotor domain, that is, activities that promote acquisition of more of practical skills are not sufficiently embedded in the strategy.

Also, the models of links being made in mind mapping-based is restricted to simple associations but does not take care of complex ones, does not give sufficient room for detail description of the concept under consideration and it also very difficult to teach equations which constitutes the limitations of the strategy.Also, mind mapping based strategy could not be effective because the strategy relies on visual representation of the content. However, the result from learning style show that most students prefer to learn through auditory, this is a direct contradiction of features of the strategy that is, representation of content through pictures

Conclusion

Sequel to the findings earlier stated, MMbS and VIS did not impact learners' practical skills in science in comparison with the CS

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