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Effects of Mind Mapping And Visual Imagery Instruction Strategies on Senior Secondary Schools Students' Scientific Attitude to Mechanics in Ekiti State of Nigeria

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Abstract: The study examined the effects of visual imagery and mind mapping strategies on physics students' scientific attitude to mechanics in Ekiti state, Nigeria. The study adopted 3 X 1 pretest-posttest control group quasi experimental research design. Eight senior secondary schools were be purposively selected for the experimental groups, while four schools were purposively selected for the control group. This made a total of twelve schools that were selected from twelve local government areas across all the three senatorial districts of Ekiti state for the study. A total number of two hundred and forty six physics students from the selected schools were used. The instrument that the researcher used for the study was self-designed instruments titled: Students' Scientific Attitude to Mechanics. The data collected were analysed using descriptive statistics (mean, standard deviation) as well as inferential statistics such as Analysis of Covariate (ANCOVA) which was used to determine the significant mean and interaction effects to the variables of the study. Estimated Marginal Mean (EMM) was used to determine the performance of each group. Bonferroni pair wise and Scheffe Post-hoc analyses were also employed to trace the source of observed significance among the groups. The finding of the study revealed that there was significant effect of treatment on students' scientific attitude to mechanics. The result further showed that those exposed to visual imagery had the highest scientific attitude mean score, closely followed by those exposed to mind mapping while those taught with conventional method of teaching had the least. Also, the finding of the study showed that there was significant main effect of gender on students' scientific attitude to mechanics. Similarly, the finding showed that there was significant interaction effect of treatment and gender on students' scientific attitude. Based on these findings, it was therefore recommended that mind mapping and visual imagery instructional strategies should be used in improving students' scientific attitude.

***Keywords**: mind-mapping; visual imagery; scientific attitude; mechanics; physics.*

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INTRODUCTION

Physics is seen as the study of interaction between matter and energy(Maera, 2016; Aladejana & Ukoh, 2022), and it is one of the compulsory subject offered in Nigerian secondary schools by science students (FME,2013). The rationale for offering it, according to Maera (2016) are to not only acquire knowledge of about our physical environment but also to create world view that gives framework that aids understanding. Basically, Physics has branches like electricity, light and mechanics. The roles of mechanics being one of the aspects of physics resonates in all facets of human endeavour. Without mincing words, every sector of the society now depends on it for proper existence. However, the performance of students in the subject still fluctuates in Ekiti. The table below gives more explanations.

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Table 1. Performance of students in Physics in the West African Senior School Certificate Examination (WASSCE) 2010-2019 in Ekiti State

Year	No of candidates	Credit (1-6) %	Pass (7-8) %	Fail (9) %	Total failure (7-9) %
2010	5765	49.77	31.66	13.30	44.95
2011	7317	83.31	9.08	1.44	10.51
2012	5155	68.17	22.87	7.53	30.40
2013	4964	56.29	28.22	13.65	41.88
2014	5862	55.61	29.56	14.82	44.39
2015	6069	47.17	33.37	19.46	52.83
2016	5231	79.77	12.83	7.40	20.33
2017	5250	51.89	34.65	13.47	48.11
2018	4989	86.63	6.84	6.53	13.37
2019	67.53	67.53	18.97	13.50	32.47

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

Table 1 showed inconsistencies in the performance of students within the years 2010 and 2019. The rate of the failure was as high as 52.83 % in 2015 and this has adverse effect on the number scientists and technonogist that will drive the economy of the world. Researches revealed strong positive relationship between performance and attitude in various fields, Physics inclusive (Ozer, 2020; Maya, 2019; Astani, Kurniawan Perdana & Kurniasari, 2019; Jana & Patra, 2017; Ayodele, 2016; Ayodele & Olatunbosun, 2015; Ryan, 2013; Fakeye, 2010), that is, attitude determines, distorts the view of ideas and influence the percentage of performance. Hence, in addressing failure rate in the performance of students in Physics, attitude is a contributive factor. Attitude, according to Adzen cited in Ozer (2020) is defined as one's disposition to respond favourably or unfavourably to a person, an object, or an institution or any other distiquishable aspect of his or her mindset. Similarly, van Gardner cited by Ryan (2013) sees attitude as the totality of individual's instinct ions and feelings, partialities, phobia and believes about specific concept. Moreso, Della (2008) as cited by Fatoba & Aladejana sees it as feeling cum opinion one has concerning things.

This attitude, in the look of science is called scientific attitude. Scientific attitude according to Farooq as cited by Astani,et al (2019) are expression or feelings that show up according to the ethics of the learners. In the same vein, Olasehinde (2014) described it as the ability to be intellectual, reasonable and not subjective in problem solving. Additionally, this scientific attitude must be paid attention to by all stakeholders if only if there is going to be improvement in students' performance because it forms creative thinking (Astani, et al,2019) and influences learning (Trumper, 2006).

Furthermore, in scientific attitude, there is existence of difference between male and female students (Fatoba & Aladejana, 2014). The characteristics that is influenced either biologically or socially is known as gender (Myers, 2002 in Fatoba & Aladejana, 2014). In order to boost the level of scientific attitude, the role images play cannot be relegated to the background because they have impacts on attitude (Brijs, Bloemer & Kasper, 2011). These images are the centrality of visual imagery and mind mapping instructional strategies. Therefore, visual imagery is referred to as the creation of images mentally while mind mapping strategy is described as representation of ideas in form of diagrammatical manner.

Based on available literature, there is dearth of literature on researches on effects of visual imagery and mind mapping instructional strategies on scientific attitude. However, the few ones in the area of attitude that were reviewed, in research, investigating self-efficacy, anxiety, attitudes and mathematical achievement regarding gender and school type, Isiksal, Recber& Koc(2018) using two-way ANOVA and multiple regression analysis found that there was a significant main effect of the gender on mean mathematics attitude scores of seventh-grade students. In contrary, Fatoba and Aladejana (2014) found that gender has no significant effects on attitude to Physics but there was slight gender difference in the attitude of male and senior secondary schools students to Physics in favour of females.

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Statement of Problem

Despite efforts made by stakeholders in education towards improvement of performance of students in Physics in senior secondary schools certificate examinations (SSCE), it is disheartening that the failure rate of Physics students are still above 30% in many years in Ekiti state which contradicts the motto of Ekiti State (fountain of knowledge) . This calls for urgent action! Researchers had attributed this problem to the poor scientific attitude towards mechanics which are traceable to inadequate instructional strategies. To solve the problem, various researchers had recommended innovative strategies such as mind mapping and visual imagery strategies.

Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

- There is no significant main effect of the treatment on students' Scientific attitude to Mechanics
- There is no significant effect of gender on students' Scientific attitude to Mechanics
- There is no significant interaction effects of treatment and gender on students' Scientific attitude to Mechanics

METHODOLOGY

The study adopted a 3 x 2 pretest-posttest control group quasi experimental research design. Twelve senior secondary schools were purposively selected for the study from twelve local government areas of Ekiti state, Nigeria, West Africa. A total number of two hundred and forty six physics students (male = 102 and female = 144) from the selected schools were used. The instruments that the researcher used for the study was self-designed instruments tittled Students' Scientific Attitude to mechanics Scale (SSAMS). The instruments contained section A and section B. The section A consisted of bio-data of the respondents on sex. The Section B of Students' Scientific Attitude to Physics Scale contained opinion with the key to the options : SA; A; D; SD.

The data collected were analysed by using descriptive statistics (mean, standard deviation) as well as inferential statistics such as Analysis of Covariate (ANCOVA) which was used to determine the significant mean and interaction effects to the variables of the study. Estimated Marginal Mean (EMM) was used to determine the performance of each group. Bonferroni pair wise Analysis and Scheffe Post-hoc analysis were employed to trace the source of observed significance among the groups.

TESTING OF HYPOTHESES

Hypothesis 1: There is no significant effect of treatment on students' scientific attitude

Table 2. Summary of ANCOVA of Effect of Treatment on students' Scientific Attitude

Variable	Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta^2
Scientific attitude	Corrected Model	141040.194	3	47013.398	353.784	.000	.814
	Intercept	104984.384	1	104984.384	790.025	.000	.766
	Covariate (Pretest-scientific attitude)	6643.730	1	6643.730	49.995	.000	.171
	Group	138773.294	2	69386.647	522.146	.000	.812
	Error	32158.765	242	132.887			
	Total	3310758.000	246				
	Corrected Total	173198.959	245				

$^*p<0.05$

Table 2 shows that there is significant main effect of treatment on students' scientific attitude ($F_{(2,242)} = 522.146$; $p<0.05$; $\eta^2=.81$). Therefore, Ho_1 is rejected.

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Table 3. Estimated Marginal Means across the Groups on Scientific Attitude

Variables	Group	N	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Scientific attitude	Visual imagery	97	131.962	1.173	129.652	134.272
	Mind mapping	70	125.466	1.378	122.752	128.180
	Control	79	78.470	1.300	75.908	81.031

Table 4. Scheffe's Post Hoc Pairwise Comparison on Scientific Attitude

Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. [b]	95% Confidence Interval for difference	
						Lower Bound	Upper Bound
Scientific attitude	Visual imagery	Mind mapping	6.496*	1.809	.001	2.135	10.857
		Control	53.492*	1.755	.000	49.261	57.723
	Mind mapping	Visual imagery	-6.496*	1.809	.001	-10.857	-2.135
		Control	46.996*	1.895	.000	42.428	51.564
	Control	Visual imagery	-53.492*	1.755	.000	-57.723	-49.261
		Mind mapping	-46.996*	1.895	.000	-51.564	-42.428

The mean difference between the scientific attitude of visual imagery and mind mapping, visual imagery and conventional, mind mapping and conventional is statistically significant in each case.

Hypothesis 2: There is no significant effect of gender on students' scientific attitude

Table 5. Summary of ANCOVA of Effect of Gender on students' Scientific Attitude

Variable	Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta^2
Scientific attitude	Corrected Model	3852.392[a]	2	1926.196	2.764	.065	.022
	Intercept	130921.172	1	130921.172	187.862	.000	.436
	Covariate (Pretest-scientific attitude)	2207.733	1	2207.733	3.168	.076	.013
	Gender	1585.492	1	1585.492	2.275	.133	.009
	Error	169346.567	243	696.899			
	Total	3310758.000	246				
	Corrected Total	173198.959	245				

p>0.05

Table 5 shows that there is no significant main effect of gender on students' scientific attitude ($F_{(1,243)}$ = 2.275; p>0.05; η^2=.009). Therefore, $Ho_{2b\ is}$ not rejected. Table 5 reveals the magnitude of mathematical skills and scientific attitude based on gender.

Table 5. Estimated Marginal Means across Gender on Mathematical Skills and Scientific Attitude

Variables	Gender	N	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Scientific attitude	Male	102	109.918	2.614	104.769	115.067
	Female	144	115.072	2.200	110.738	119.405

Table 5 shows that female physics students had scientific attitude mean score of 115.072 while their male counterparts had 109.918. The mean difference between these groups is not statistically significant in each case.

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Hypothesis 3: There is no significant interaction effect of treatment and gender on students' scientific attitude

Table 6. Summary of ANCOVA of Interaction Effect of Treatment and Gender on students' Mathematical Skills and Scientific Attitude

Variable	Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta^2
Scientific attitude	Corrected Model	143276.690[a]	6	23879.448	190.734	.000	.827
	Intercept	100665.207	1	100665.207	804.049	.000	.771
	Covariate (Pretest-scientific attitude)	4614.877	1	4614.877	36.861	.000	.134
	Treatment	139420.674	2	69710.337	556.802	.000	.823
	Gender	395.250	1	395.250	3.157	.077	.013
	Treatment * Gender	1922.562	2	961.281	7.678	.001	.060
	Error	29922.270	239	125.198			
	Total	3310758.000	246				
	Corrected Total	173198.959	245				

*$p<0.05$

Table 6 shows that there is significant interaction effect of treatment and gender on students' scientific attitude is statistically significant at 0.05 level ($F_{(1,239)} = 7.678$; $p<0.05$; $\eta^2=.060$). Therefore, $Ho4_{b\ is}$ rejected. Table 7 reveals the magnitude of mathematical skills and scientific attitude across the treatment and gender.

Table 7. Estimated Marginal Means showing interaction of Treatment and Gender on Scientific Attitude

Variable	Treatment	Gender	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Scientific attitude	Visual imagery	Male	133.956	1.816	130.379	137.533
		Female	130.573	1.459	127.698	133.448
	Mind mapping	Male	124.904	2.140	120.689	129.119
		Female	125.830	1.742	122.398	129.261
	Control	Male	72.971	1.881	69.267	76.676
		Female	83.227	1.748	79.783	86.670

Table 7 showed that there is mean difference between male and female mathematical skills when various treatment was administered to them with (means for visual imagery: Male = 15.562, female= 15.611; means for mind mapping: Male = 13.510, female= 13.546; and means for control: male=9.185; female = 8.621) respectively. Similarly, there is a mean difference between male and female scientific attitudes when various treatment was administered to them (means for visual imagery: Male = 133.956, female= 130.573; means for mind mapping: Male = 124.904, female= 125.830; and means for control: male=72.971; female = 83.227) respectively.

DISCUSSION OF FINDINGS

The study is on the effects of mind mapping and visual imagery strategies on Physics students' scientific attitude to mechanics in senior secondary schools in Ekiti state, Nigeria. The finding of the hypothesis Ho1 showed that there was main effect of treatment on students' scientific attitude. Moreso, the mean difference between the scientific attitude of visual imagery and mind mapping, visual imagery and conventional, mind mapping and conventional is statistically significant in each case. Similarly, the finding of hypothesis 2 showed that gender has no significant main effect on students' scientific attitude. This finding corroborate earlier finding of Fatoba and Aladejana (2014) who found that gender has no significant effects on attitude to Physics. However, the finding is in disagreement with the earlier finding of Isiksal, Recber& Koc (2018) who found that there was a significant main effect of the gender on mean mathematics attitude scores of seventh grade students. Furthermore, the finding of the hypothesis 3 showed that there was significant interaction effect of treatment and gender on students' mathematical skills. Similarly, the finding of hypothesis 3 that the interaction effect of treatment and gender on students' scientific attitude is statistically significant

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CONCLUSION

The findings have aided the researcher to conclude that mind mapping and visual imagery strategy instructional strategies have effects on students' scientific attitude mechanics in Ekiti state senior secondary schools. Moreso, Use of the two strategies, either singly or jointly showed that students' scientific attitude to Mechanics could be improved. The two strategies also helped students' participation in the classroom as they are learner-centered strategies. Similarly,based on the findings of this study, it is evident that gender has no significant effect on students' scientific attitude.

RECOMMENDATIONS

Based on the findings so far, the following recommendations are therefore made:

- Mind mapping and visual imagery instructional strategies should be used in improving students' scientific attitude;
- Teachers should adopt the use of the strategies as instructional strategies
- Sponsorers of learners should motivate their wards to equally make use of mind mapping and visual imagery as learning strategies;
- Government should provide conducive amenities that will assist in the usage of the strategies.

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