Science Journal of Education
2021; 9(6): 221-225
http://www.sciencepublishinggroup.com/j/sjedu
doi: 10.11648/j.sjedu.20210906.14
ISSN: 2329-0900 (Print); ISSN: 2329-0897 (Online)

Physics Students' Level of Capability and Attitude in Handling Mapping Concept: A Tool for Metacognitive Ability Enhancement

Theresa Ugonwa Okafor

Department of Science Education, Faculty of Education, Chukwuemeka Odumegwu Ojukwu University, Uli, Nigeria

Email address:
teresaokafor@gmail.com

To cite this article:
Theresa Ugonwa Okafor. Physics Students' Level of Capability and Attitude in Handling Mapping Concept: A Tool for Metacognitive Ability Enhancement. *Science Journal of Education*. Vol. 9, No. 6, 2021, pp. 221-225. doi: 10.11648/j.sjedu.20210906.14

Received: October 29, 2021; **Accepted**: November 27, 2021; **Published**: December 24, 2021

Abstract: The utilization of insufficient methodology for solving difficult concepts is one of the most referred to issues in executing science educational plans. This makes it imperative to suggest an approach for teaching physics that aims at enhancing understanding rather than promoting rote-learning, memorizing, and juggling of facts. An effective way of dealing with this problem is for the physics teacher to provide a bridge between the unfamiliar concepts and the knowledge which physics students already have. This research investigated physics students' capability and attitude in handling mapping concept as a tool for metacongnitive enhancer.. The population of the study consist of all senior secondary school students (SS2) in Dunkofia Local Government area of Anambra State Nigeria with total sample under study as seventy six (N =76). The physics students were divided into Experimental and Control group with thirty eight (n=38) students in each group. The research instrument were validated by Physics Mapping Concept Capability Test (PMCCT), Physics Mapping Concept Attitude Test (PMCAT) which contained ten (10) item each and a summarized work on mapping concept. Reliability of the data instrument were 0.74 and 0.81 as regards to the pilot study. Two research questions and hypotheses were developed. These questions were answered using mean and standard deviation whereas the hypotheses were tested at probability less than 0.05 significant level using t-test statistics. Furthermore questionnaires were also used to evaluate student's capability in handling mapping concept. Overall, the result of the study indicated that the experimental group exceptionally performed better than the control group. It is therefore, evident from the drawn conclusions that students' capability in handling mapping concept tool enhances metacognitive ability and with a positive attitude at a very large extent.

Keywords: Capability, Attitude, Mapping Concept, Metacognitive Ability Enhancement

1. Introduction

Perhaps the most referred to issues in executing science educational plan has been the utilization of insufficient methodology for solving difficult concept [1]. A part of accentuation has been put in this by the test science educational plan projects at both the nearby and worldwide levels. But despite the amount of effects and emphasis, science teachers (physics inclusive) in Nigerian schools still revert to the use of 'chalk and talk' method for teaching rather than interactive and investigative approaches [2]. It seems that physics teachers are incompetent in the use of innovative strategies.

The utilization of physical science through innovation is significant for providing the infrastructural needs in the society. Effective delivery of physics curriculum is no doubt a sine-qua non to sustainable technological development. Physics is one of the fundamental ingredients of technology. And as such, there is need for appropriate conveyance of physics educational plan in senior secondary schools. Research findings have shown Exploration discoveries that various topics in physics science contains a few ideas which present extraordinary what's more, considerable difficulties to the students ([3, 4]). More, part of the problem is that the reform efforts center on student learning but not on teacher-learning. If teachers are therefore provided with innovative curricular and are thought how to use them, they will be effective in implementing the innovative curricular in

the classroom level [5]. Obviously when concepts are not seriously perceived by physical science students, they will in general avoid questions set on them during Senior Secondary Certification Examination (SSCE). Invariably, this may lead to poor performance of students in these areas, vis-a-vis the overall performance of students in physics students at SSCE.

This makes it imperative to suggest an approach for teaching physics that aims at enhancing understanding rather than promoting rote-learning, memorizing, and juggling of facts. An effective way of dealing with this problem is for the physics teacher to provide a bridge between the unfamiliar concepts and the knowledge which physics students already have. This is based on the premise that new concepts do not exist in isolation but depend upon others for meaning. Mapping concept has been enough pushed in the writing as systems for significant learning of unique ideas and help students into finding out about reasonable changes [6]. Mapping concept is one of the teaching learning strategies under constructivism having its orientation in Ausbels' [7] assimilation theory of cognitive learning, aimed at fostering meaningful learning by students. It uses socially rich environment where students work both independently and in gatherings to framework and ruminate learning of one another [8, 9]. According to Okafor and Okeke [5], mapping concept is based on the fact that meaningful learning occurs when new knowledge is consciously explicit and deliberately linked with relevant concepts, which the learner already knows. The use of this tool as technique in teaching abstract concepts in physics may be observed as a paradigm shift.

Mapping concept (MC) is a teaching and learning strategy that establishes a bridge between how people learn, knowledge and sensible learning and useful in enhancing meaningful learning and students' conceptual understanding. Students need to have sufficient foundation and a critical thinking about MC and the relations between different concepts.

Mapping concept involves a hierarchical presentation of ideas from known to unknown and usually presented in a flow-chart pattern moving from the top to the bottom. Mapping concept has proved to be useful in teaching science concepts [8, 10-12]. One major benefit of utilizing idea maps is that during its definition interaction it consolidates a concrete and precise understanding of the meanings and inter-relations of concepts. Thus it makes learning an active process, not a passive one [13]. It is believed that one of the reasons mapping concept is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks [14]. Several studies have found the use of mapping concept very effective in their science teaching and learning [15]. Little have been studied about the level of physics students' capability and attitude in handling mapping concept as a tool for metacongnitive enhancement.

They also posited that capability refers to combination of knowledge of skills and attitudes that can be developed through training which that are adequate for accomplishing some specific tasks.

In view of the aforementioned, the main aim of this study was to examine the level of physics students' capability and attitude in handling mapping concept as a tool for metacongnitive enhancer.

2. Research Questions of the Study

1) Is there any level of difference in the evaluation of students in the (PMCCT) of the experimental and control groups.
2) What is the level of difference in the evaluation of students in the (PMCAT) of the experimental and control groups.

Hypotheses

Ho_1: There is no significant difference in the evaluation of students in PMCCT of the experimental and control groups.

Ho_2: There is no significant difference in the evaluation of students in PMCAT of the experimental and control groups.

3. Procedures of Study/Methodology

The research was achieved by adopting mixed method approach. Open-ended and Closed-ended data with single investigation of data collected and analyzed. The sample under investigation consist of senior secondary school physics students (SS2) in nine (9) public secondary schools in Dunukofia local government area from Anambra State post primary schools management board (PPSMB 2017/2018). The samples are made up of seventy six (N =76) with (n =38) students in each group randomly selected and comprising of two parts. Part A: experimental group and B: control group respectively.

Instruments employed for the Closed-ended data analysis were Physics Mapping Concept Capability Test (PMCCT), Physics Mapping Concept Attitude Test (PMCAT) and a summarized work on mapping concept. (PMCCT) and (PMCAT) contains 10 item each and multiple choice questions on basics of heat as a form energy sourced from past questions set by Senior Secondary School Certificate Examination (SSCE) while the Open-ended instrument for data collection used Physics Students' Mapping Concept Capability Questionnaires (PSMCCQ) developed by Ezekannagha [16] and adopted by the researcher.

The instruments were validated by volunteered assistance of lecturer's in physics department from Chukwuemeka Odumegwu Ojukwu University (COOU). Their corrections, suggestions and recommendations regarding the face and content validity of the items were effected and used to produce the final version of the instruments. The instruments were tested for reliability using Cronbach Alpha and found out to be 0.79 and 0.80. This was considered adequate for the instrument.

The research study compares the mean scores of Experimental group taught using mapping concept and the other taught in the conventional lecture manner (Control group). A pretest was carried out on (PMCCT) and (PMCAT)

in order to ascertain problem-based learning progress in terms of academics ability. Furthermore, a posttest which is the mirror-image of the pretest was administered again to both group. Research questions were answered for each group using mean (X) and standard deviation (SD) scores while the hypotheses were tested on the base of its significant using a software program of statistical package for social sciences (SPSS).

The Questionnaires were administered by the researcher to the Experimental group immediately after the posttest and collected on the spot. The data collected were answered using mean and standard deviation for the questions. The questionnaire consisted of 10 Likert items with the mode of responses as highly capable (HC), moderately capable (MC), lowly capable (LC), and incapable (I) with rating grade of 4, 3, 2, and 1 respectively. Also any mean of 2.50 and above is regarded as one in which the physics students are capable and a mean of less than 2.50 regarded as one in which the physics students are incapable. All the items were to test the students' level of capability in handling mapping concept. The study took exactly six (6) weeks for complete execution.

4. Results Analysis

The results for this study are presented as follows:

4.1. Research Question One

Is there any level of difference in the evaluation of students in the (PMCCT) of the experimental and control groups.

Table 1. *Mean and Standard Deviation for the PMCCT analysis of Experimental and Control group.*

Groups	**Experimental Group**			**Control Group**			
Instruments	N	Mean	SD	N	Mean	SD	Mean difference
PMCCT	38	63.07	13.67	38	53.76	15.23	9.31

SD: Standard deviation.

The mean score for the experimental group (Mean = 63.07, SD = 13.67) and control group (Mean = 53.76, SD = 15.23) is shown in Table 1. It can be observe that the difference in mean scores of the experimental group is comparatively higher than the control group with mean difference as 9.31 while the standard deviations were consistently lower. This significant difference in mean score is an evidence to show that there is high capability of students with knowledge of mapping concept to have a good command of the subject matters.

4.2. Research Question Two

What is the level of difference in the evaluation of students in the (PMCAT) of the experimental and control groups.

Table 2. *Mean and Standard Deviation for the PMCAT analysis of Experimental and Control group.*

Groups	**Experimental Group**			**Control Group**			
Instruments	N	Mean	SD	N	Mean	SD	Mean difference
PMCAT	38	58.89	13.20	38	51.02	14.00	7.87

The mean attitude score for the experimental group (Mean = 58.89, SD = 13.20) and control group (Mean = 51.02, SD = 14.00) is shown in Table 2. It can be observe that the difference in mean scores of the experimental and control group in (PMCAT) follows similar trend in (PMCCT) with mean difference as 7.87 while the standard deviations were consistently lower.

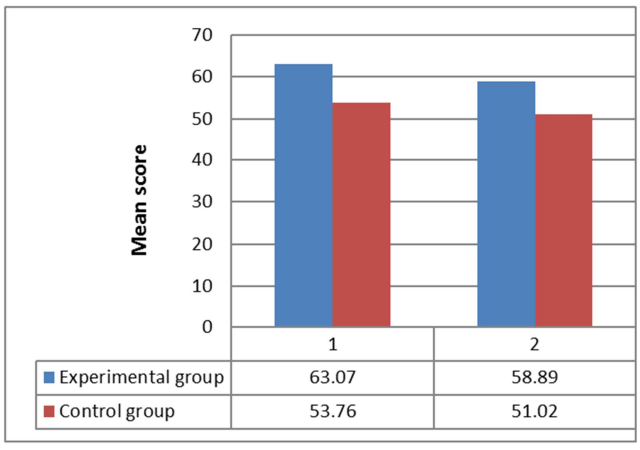

Figure 1. *PMCCT and PMCAT of the analysis.*

The bar charts shows the experimental and control group of the mean score results in Figure 1 clearly illustrating the high significant difference between the two group with the experimental group significantly higher than the control group indicating the effectiveness of the use of mapping concept by the students and teachers in physics schools in the teaching and learning process. It can be further agreed that the group that used mapping concept performed better in the test than the group that used the conventional lecture method. This study aligns with the findings of Dennis et al [17] who ascertained that generally, mapping concept have positive effect on student's attitude and enhance student's capability to access new ideas.

4.3. Hypotheses

To determine whether the difference is significant or not, the scores were subjected to t-test analysis.

4.3.1. HO_1

There is no significant difference in the evaluation of students in PMCCT of the experimental and control groups.

Table 3. *t-test statistics of mean difference for experimental and control groups.*

Groups	Experimental Group			Control Group					
Instruments	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-cal**	**t- critical**	**Remark**
PMCCT	38	63.07	13.67	38	53.76	15.23	2.064	1.45	Significant

Table 3 revealed that the calculated t-value is 2.064 and the critical t-value is 1.45. Since the calculated t-value is greater than the critical t-value, the null hypothesis is rejected showing that there is statistically significant difference in the physics student competencies in the use of concept mapping across the group, therefore the reverse becomes accepted.

4.3.2. HO_2

There is no significant difference in the evaluation of students in PMCAT of the experimental and control groups.

Table 4. *t-test statistics of mean difference for experimental and control groups.*

Groups	Experimental Group			Control Group					
instruments	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**t-cal**	**t- critical**	**Remark**
PMCAT	38	58.89	13.20	38	51.02	14.00	2.01	1.45	Significant

Table 4 shows that the calculated t-value is significantly greater that the critical t-value (2.01>1.45) proving that there is statistically significant difference between the mean attitude scores for both groups. Hence the null hypothesis rejected.

4.4. Questionnaire Result Analysis

Capability of students in handling mapping concept in physics subject were determined by the use of questionnaires which assisted in understanding the level of the student capability with the Likert items.

Table 5, revealed that the physics students were found capable in almost all the Likert items (1, 2, 3, 4, 6, 7, 8, 9 and 10) with item (2, 6, 9 and 10) having a higher mean score than others and incapable in one item (5).

Table 5. *PSMCCQ Responses.*

S/N	ITEMS	X	SD
1	Select topics for mapping concepts activities.	2.64	0.90
2	Understands how to construct concepts maps.	3.52	1.09
3	Identifying physics concepts necessary for understanding a particular physics topic as key words or phrase.	2.55	0.61
4	Initiate discussion with the most inclusive idea in the text and the most important one.	2.51	0.67
5	Cluster concepts that function at similar level of abstraction and those that interrelate closely.	1.97	0.65
6	Arrange physics concepts and main ideas in hierarchical order from the most general, inclusive and abstract (super ordinate) to the most specific and concrete (sub-ordinate).	3.07	1.65
7	Linking physics concept with link lines.(prior and new knowledge).	2.60	0.80
8	Choose good linking words to form the preposition shown by the lines of the map.	2.56	0.65
9	After been taught using mapping concept in physic, I can now use concept maps when revising for other physics topic	3.86	1.02
10	Look for cross-links between concept in one section of the map and concepts in the other part of the concept tree. Provide examples if possible at the terminus of each branch (string of relationship).	2.98	1.08

5. Results Discussions

This study is clearly showed from tables 1, 2, 3, and 4 that the differences in mean score are statistically significant in favor of the experimental group. This implies that student taught using mapping concept showed they are more capable, have a positive attitude and better performance than those taught using convectional lecture method. It also means learning is more imparted positively through mapping concept than through the convectional lecture method. This is in line with the view of previous findings of Arokoyu and Obunwo [15]; Jiang, [18]; Broggy and McClelland [19] that students' understanding is enhanced by the use of mapping concept. Hence, the reason for the significant difference between the mean scores of the experimental and control groups could be attributed to the fact that the use of concept maps are project based-learning. It is believed according to Vanides, et al [20] and Josiah [21] that mapping concept helps students to understand and organize what they learn better and enable students store and retrieve information more efficiently.

The Likert items formulated in this study is to help us understand the learners' capability in handling mapping concept in Table 5. It clearly shows that physics students are competent in the use of mapping concept indicating that physics students are taught using concept maps to identify key words necessary for understanding a particular physics topic and can cross-link concepts. They also find it very easy to cluster concepts in hierarchical order from the most general to the concrete.

The finding of this study correlates with previous findings of Eze and Ezeugo [9]; Arokoyu and Obunwo [15]; Dennis, Kaumba and Jack [17] Otor [22]. They concluded that students taught some concepts in physics, chemistry and basic science respectively using mapping concept achieved higher and better performance than other students taught using convectional teaching method. Also students have positive attitude towards the use of mapping concept. According to Novak and Gowing

[8]; Broggy and McClelland [19], this theory is based on the fact that students easily learn new things by making use of existing knowledge and then devise a means to assimilate the newly acquired knowledge which is based on interest.

6. Conclusion

The study compared physics students' level of handling mapping concept to the conventional learning method.

In the analysis of Physics Mapping Concept Capability Test (PMCCT), it showed that students in experimental group performed better than those of the control group; which revealed that the use of mapping concept enhanced student's capability and interest in physics study.

Also in the analysis of Physics Mapping Concept Attitude Test (PMCAT), it showed that students in the experimental group have positive attitude and performed better than the control group. The use of mapping concept was therefore greatly successful than the convectional learning method. This means that mapping concept greatly influences the student's attitude positively.

The questionnaire findings showed that students have high level of capacity in handling mapping concept. The students' in the experimental group outperformed better than the control group.

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