CONCEPT-MAPPING: AN INNOVATIVE PEDAGOGY TO ENHANCE ACADEMIC PERFORMANCE IN SCIENCE AMONG PRIMARY SCHOOL CHILDREN IN ZARIA, NIGERIA

ASABE RAMATU NURU; AISHA YAKUBU ISAH; BARAKAT TAHIR NUHU
Biology Department,
Federal College of Education,
P. M. B. 1041, Zaria.
E_Mail: faridanuru03@gmail.com

Abstract

This quasi-experimental study investigated the instructional impact of Concept-Identifying concept-mapping strategyas an innovative pedagogy to enhanceacademic performance in basic science among primary school children in Zaria, Nigeria. A sample of 363 pupils (188 Control group & 175 Experimental group) in intact classes from fourpublic primary schools (2 experimental & 2 control) was randomly drawn from the population of 14,749 pupils. Human Circulatory System topic was selected for the study. The experimental groups were taught using Concept Identifying Concept-Mapping Strategy while the control groups were taught with didactic lecture method respectively for six weeks. The instruments used for data collection were Basic Science Performance Test (BSPT) and Concept-Identifying Concept-Mapping Test (CICMT). Instruments were validated by experts. BSPT had a reliability coefficient of 0.82 using test-retest method while Inter-Rater Reliability for scoring the CICMT was 0.80. Two research questions raised were answered using means and standard deviations while the null hypotheses were tested at P≤0.05 using t-test statistics. Results showed that the Concept-Identifying Concept-Mapping strategy had a significant impact on the performanceof pupils than didactic lecture method (P < 0.05). Also, there was no significant difference between mean rubric scores of male and female pupils in this study (P > 0.05). Based on these findings, it was recommended that Concept Identifying Learning Strategy may be a useful scaffold in teaching primary pupils how to create their concept maps and consequently enhance learning.

Keywords: Impact, Concept-mapping, Concept-Identifying Strategy, Pedagogy, Basic Science, Academic Performance, Pupils
DOI: https://doi.org/10.35386/ser.v19i1.80

Introduction

Primary education in Nigeria is the aspect of basic education offered to every child of school age (6-12 years). It is the foundation of education where children are prepared for post-basic and tertiary education. The goal of primary education in the National Policy on Education (FRN, 2013) is among others, the need to lay a sound basis for scientific, critical, and reflective thinking. The policy also emphasizes on exploratory, experimental, and child-centred learning. The performance of Nigerian primary pupils in science at international and national examinations is poor. This is evident from the Second International Science Study in which Nigerian pupils came last in primary science. (Ogunmade, 2005; Shaibu, 2014). Studies of Wilmut and Yakasai (2006) also reported poor performance of primary pupils in Kaduna-state. The trend of questions in National Common Entrance Examinations requires pupils to apply and synthesize concepts before offering solutions to problems rather than direct regurgitation of facts. To answer such questions confidently, pupils need to be taught to fully understand, link and apply the learnt concepts. In line with the National Policy on Education (2013), Kaduna state abandoned the common entrance examinations in public primary schools in 2005 and now operates continuous assessment through primary 1-6

monitored by Universal Basic Education Commission (UBEC). Wilmut andYakasai (2006) observed that the use of continuous assessment is still inadequate in addressing poor performance.The Education Sector Support Programme (ESSPIN) assessment of primary school pupils in Kaduna-state on literacy and numeracy learning outcomes against the primary education benchmarks revealedoverall average low scores ranging between 1.4% - 13.2% (ESSPIN Composite Survey 1, 2012). These still indicate poor performance in public primary schools in Kaduna-state.

One of the factors identified to be responsible for persistent poor performance in science by students in Nigeria is the use of inappropriate instructional teaching/learning strategies (Akeju, Rotimi & Kenni, 2011; Shaibu, 2014). The pedagogical method of teaching science in primary schools is didactic and does not engage pupils actively (Ling & Boo, 2007; ESSPIN, 2013). This instruction encourages passive learning and forming of misconceptions by pupils which influence how they interpret and construct new knowledge. Due to the rapid changes in science, meaningful learning strategies are becoming more important for primary school children who will need to keep abreast of these changes as they relate to process of learning (ESSPIN, 2013). Several pieces of research in science education such as Roth, 1993; American Association for the Advancement of Science, 1993; National Research Council, 1996; Akeju, et al., 2011; Gallenstein, 2013 among others have shown the efficacy of innovative teaching strategies and there has been interest in reforming the way science is taught in primary schools. It has been well established that showing children how to represent information visually, not only stimulates but also increases their brain activity (Birbili, 2006). An effective way to help children represent what they know and understand in visual forms is concept-mapping.

Concept-mapping is an activity that will provide the learners with the opportunity to organize, summarize, analyze and evaluate many different ideas. Thus, it promotes the development of critical thinking skills, which can then be used for other meaningful learning activities. It is an educational tool that is used to facilitate and demonstrate learner's comprehension through the use of a visual medium (Brinkerhoff & Booth 2013). Manoj and Mohammed (2013) defined Concept maps as graphical tools for seeking, organizing and representing new knowledge.Concept Maps are powerful tools for the facilitation of meaningful learning and the Concept-Identifying strategy serves as a kind of scaffold to help learners to organize knowledge and to structure it into units of interacting concepts and propositional frameworks (Emmanuel, 2013). Concept-Identifying maps are partially completed concept maps that students complete by finding the correct concepts to place in the nodes (Wang & Dwyer, 2006). Within the partially complete concept-mapping strategies (fill-in-the-map) in which pupils were required to complete the maps with randomly deleted pieces of information from an expert/teacher generated map, the difficulty level of concept-mapping task can be varied. Once the pupils are familiar with the idea and process, they can construct their maps eventually either individually or collaboratively.

Novak in his New Model for Education (Anohina-Naumeca, 2014) advocated the use of expert generated skeleton (fill-in-the-map) concept maps to serve as a scaffold to learning, Studies (Soleimani & Nabizadeh, 2012; Anohina-Naumeca, 2014) have also found out that scaffolding instruction combined with completion strategy enhances students learning ability and the degree of transfer of knowledge. The fill-in-the-map

used in this study (Concept-Identifying) was designed and used based on the combination of Scaffolding instruction and Completion strategy by Van-Merrienboer (1990). Concept mapping tasks where pupils are required to fill-in-the-map provides an adequate degree of hierarchical structure and sufficient potential for self-construction of a more accurate concept map. Ferry (1997) and Sparks-Linfield and Warwick (2003) opined that young children need to be taught the technique of concept-mapping by simplifying it using scaffolds before they can successfully construct their maps. Pupils with limited prior knowledge and low ability levels would also benefit from tasks involving partially completed maps. Concept-mapping has been applied at different levels of education and it is a widespread strategy all over the world and its usefulness as a learning strategy for young children has been demonstrated (Gallenstein, 2013) but research evidence has shown that there is little or no studies were done in Nigeria to determine the impact of concept-mapping on understanding and performance in primary science. Primary six pupils were chosen for this study because concept-mapping should be introduced to children after they have had many opportunities to manipulate real objects, observe, record and communicate their learning experiences. Among others, studies to determine gender differences in concept mapping among secondary school students such as Chawla and Singh (2015) on Effect of Concept Mapping Strategy on Achievement in Chemistry of IX Grader girlsand Onuoha, Ejimonye, Eneogu and Ugwuanyi, (2016) on Effect of Concept Mapping Instructional Strategy on Students' Achievement and Interest in Economics in Secondary Schools in Enugu Education Zone, Nigeria, have revealed a no significant gender difference. This study intends to determine if gender differences will occur in concept mapping activities among primary pupils. This study extends the research in concept-mapping as an effective pedagogy into primary science classrooms to enhance pupils understanding of science concepts and academic performance.

Objectives of the Study

The Objectives of this study were to determine:

1. the impact of Concept-Identifying Concept-mapping strategy on academic performance of primary pupils in Basic Science in Zaria.
2. if gender disparity exists in the performance of pupils in concept-mapping activities in Basic Science.

Research Questions

The following research questions were formulated to guide the conduct of the study:

1. What is the difference in the mean posttest scores of primary school pupils taught using Concept-Identifying Mapping Strategy and lecture method?
2. Will there be any difference in the mean rubric scores of males and females in understanding the Concept-mapping strategy among primary pupils in Zaria?

Null Hypotheses

The following null hypothesis was postulated to guide this study at $P \leq 0.05$ significance level:

$H0_1$: There is no significant difference in the mean posttest scores of pupils taught with Concept-Identifying mapping strategy and Lecture method among primary pupils in Zaria.

$H0_2$: There is no significant difference in the mean rubric scores of males and females in understanding the Concept-Identifying mapping strategy among primary pupils in Zaria.

Methodology

The design for this study was a two-by-two (2x2) factorial quasi-experimental study. The population of the study involved all primary six pupils (14749)of 116 public primary schools in Zaria metropolis as of 2017. Stratified sampling was used to select four schools which were assigned codes such as A, B, C & D. Because of the nature of the experiment, four intact classes were randomly selected by balloting from the four schools to serve as a sample for the study (Sambo, 2005). School A & B served as experimental groups while School C & D were the control groups. The sample selected for the study was 363 (188 Control group & 175 Experimental group).

Four Science Education experts with PhD from Ahmadu Bello University, Zaria validated the instruments for this study. Pilot testing was done to determine the inter-rater reliability of scoring the concept-maps. All maps created by the subjects were evaluated using a scoring instrument created by Lomask, Baron, Greig and Harrison (1992).The researcher and one of the experienced primary school teachers, from one of the sampled schools, scored six concept maps together. Subsequently, each scorer individually scored five of the same Concept-Identifying concept maps. Inter-Rater Reliability (IRR) was calculated with Cohen's kappa to be 0.80. All pupils in the experimental groups received one week (35 minutes each day) training on Concept-Identifying strategy by the researcher before the commencement of treatment. The training includes an introduction to concept-mapping, guided practice, independent practice, and feedback on the concept maps. The training was necessary to introduce and teach pupils how to generally construct concept maps. A BSPT pretest was administered to all subjects in the study. Treatment was done for six weeks by teaching Human Circulatory System topic in first term scheme of work of primary six by the researcher and pupils were provided with the Concept-Identifying maps which already consists of propositions arranged hierarchically for them to fill in. Concept maps were scored and feedback was always given to the pupils at the end of every lesson. Control group were taught the same topics with didactic lecture method for six weeks also. Data were collected by administering a reshuffled BSPT as a posttest to both groups and additionally fill-in-the-map Concept-Identifying Mapping Test was administered to the experimental group only. Frequency, simple percentages, means, standard deviation, and t-test was used to analyze data and to test the null hypotheses using SPSS version 20 at $P \leq 0.05$ level of significance.

Results

Table 1: Summary of t-test on Mean Scores of Posttest of Pupils in Experimental and Control Groups

Variables	N	Mean	SD	S.E	t-value	df	P-value	Decision
Experimental Group	175	44.06	13.06	0.99	4.63	361	0.02	Significant
Control Group	188	30.24	7.78	0.57				

*****Significant at P < 0.05

Results in Table 1 revealed a significant difference between the two strategies. The Concept- Identifying Mapping Strategy (experimental group) had a higher mean score and was better in enhancing learning than didactic lecture method at the primary school level.

Table 2: Summary of t-test on Mean Rubric Scores of male and female Pupils in Experimental Group only

Sex	N	Mean	SD	S.E	t-value	df	P-value	Decision
Male	87	3.03	0.706	0.12	2.97	173	2.44	Not Significant
Female	88	2.58	0.705	0.09				

***NS** at P < 0.05

Table 2 revealed a no significant difference between male and femaleprimary pupils taught with the Concept-Identifying Mapping strategy. This means that gender has no effect when teaching with the strategy.

Discussion

T-test comparison in Table 1 revealed that there was more improvement in academic performance among students in the experimental group than were observed in the control group. The observed variability was found to be statistically significant. The null hypothesis was therefore rejected. Result of the current study supports previous studies such as Birbili (2006) andAsan (2007) who both concluded that concept-mapping is an effective strategy that leads to meaningful learning in children.Studies carried out among Nigerian Secondary Schoolswith Concept-Mapping Instructional Strategy such as Akeju, *et al*., (2011)Teaching with Concept-Mapping Instructional Strategy; Ozoji (2013)Effect of concept-mapping technique on students' cognitive development in Plateau-state, Nigeria and its implications for Science and Technology instruction and Fatokun and Enaiyeju (2014) The Effects of Concept Mapping Guided Discovery Integrated Teaching Approach on Chemistry Students Achievement and Retention,all reported similar findings from their studies thatConcept-mapping technique had a significant effect on students' performance. This result is also in line with Wang and Dwyer (2006) and Dosanjh (2011) who established that the Concept-Identifying Mapping Strategy enhanced performance better than other strategies in concept mapping activities.

A significant difference in the rubric scores obtained by male and female pupils taught using the Concept-Identifying concept-mapping strategy was tested in null hypothesis two. The result of the t-test revealed that the male and female pupils did not differ significantly in their mean rubric scores (Table 2). The null hypothesis was therefore retained. This result revealed that gender may not play a significant role in the impact of the Concept-Identifying concept-mapping strategy. This finding is like Chawla and Singh (2015) and Onuoha *et al.,* (2016) findings which revealed no gender effect on performance.

Conclusion

The Concept Identifying Mapping Strategy adopted in this study which were Fill-in-the-maps made from expert/teacher concept maps enhanced performance of pupils and may be useful in assessing pupils' knowledge in concept-mapping. The scaffolding technique involved enabled pupils to be able to comprehend and construct their maps faster and easier. Results from this study highlight the need to evaluate and analyze Concept maps created by pupils to understand their knowledge and performance instead of analyzing pre/post-multiple-choice tests. These will provide teachers with more complete information regarding students' knowledge. The Concept-Identifying Mapping strategy used in this study isalso gender friendly and can be used to enhance performance in Nigerian primary school classrooms.

Recommendations

The following recommendations are made based on the outcomes of this study:

1. Primary science teachers should adopt the Concept-Identifying Mapping Strategy as a useful scaffold in teaching primary pupils how to create their concept maps and consequently enhance learning.
2. Future Concept-mapping studies that will be conducted in Nigeria should assess pupil's concept maps for accuracy in addition to determining the effectiveness of concept-mapping strategy from pre/posttests.
3. Primary science teachersshould begiven maximum cooperation, motivation and facilitation by the state government, academic planners and administrators to adopt innovative teaching strategies like Concept Identifying Mapping Strategy to increase understanding of pupils and thereby enhance academic performance.

References

Akeju, O. S.; Rotimi, C. O. & Kenni, A. M. (2011). Teaching With Concept-Mapping Instructional Strategy In Nigerian Secondary Schools. *Proceedings of the 2011 International Conference On Teaching, Learning and Change*, 637-643.

American Association for the Advancement in Sciences (1993). *Benchmarks for Science Literacy*. Oxford University Press. *www.aaas.org*

Anohina-Naumeca, A. (2014). Finding factors influencing students' preferences to concept-mapping tasks: literature review. *Procedia – Social and Behavioural Sciences*, **128**: 105-110.

Asan, A. (2007). Concept Mapping in Science: A Case Study of Fifth Grade Students. *Educational Technology & Society*, **10** (1): 186-196.

Birbili M. (2006). Mapping Knowledge: Concept Maps in Early Childhood Education. *ECRP*, **8** (2): 1-13.

Brinkerhoff, L. J. & Booth M. G. (2013). The Effect of Concept Mapping On Student Achievement in an Introductory Non-Majors Biology Class. *European International Journal of Science and Technology*, **2** (8): 43-72. *www.eijst.org.uk*

Chawla, J. & Singh, G. (2015). Effect of Concept Mapping Strategy on Achievement in Chemistry of IX Grader girls. *International Journal of Informative & Futuristic Research*, **3** (3): 1036-1044.

Dosanjh, N. K. (2011). The Effects of Three Concept Mapping Strategies on 7th Grade Students Science Achievements at an Urban Middle School. University of San Francisco, Proquest, UMI Dissertations Publishing.

Emmanuel, E. O. (2013). Effects of concept mapping strategy on students' achievement in difficult chemistry concepts. *Educational Research*, **4** (2): 182-189.

Education Sector Support Programme (ESSPIN, 2012). ESSPIN Composite Survey 1, 2012. *www.esspin.org*.

Education Sector Support Programme (ESSPIN, 2013). Annual Report 2012-2013. ESSPIN 065. *www.esspin.org*.

Fatokun, K. V. F. & Enaiyeju, A. A. (2014). The Effects of Concept Mapping Guided Discovery Integrated Teaching Approach on Chemistry Students Achievement and Retention. *Educational Research and Reviews*, **9** (22): 1218-1223.

Federal Republic of Nigeria (2013). *National Policy on Education (6th Edition)* Lagos: NERDC Press.

Ferry, B. (1997): Using concept maps to help students to organize the content of your lectures. *University of Wollongong Overview*, **4** (1): 3-8. *www.cedir.uow.edu.au*

Gallenstein, N. (2013). Concept Mapping for Learners of all Ages. *Journal for Educators, Teachers and Trainers*, **4** (1): 59-72.

Ling, Y. & Boo, H. K. (2007). Concept Mapping and Pupils Learning in Primary Science in Singapore. *Asia-Pacific Forum on Science Learning and Teaching*, **8** (2): article 11.

Lomask, M.; Baron, J. B.; Greig, J. & Harrison, C. (1992). Connecticut's Use of Concept Mapping to Assess the Structure of Students' Knowledge of Science. A Paper Presented at the Annual Meeting of the National Association of Research in Science Teaching. Cambridge, MA *www.jec.sagepub.com/content/….*

Manoj, K. & Mohammed, R. (2013). Impact of Teaching through Concept mapping on Achievement in Social Studies' Components. *International Indexed & Refereed Research Journal*, **4** (46): 54-57.

National Research Council (1996). *National Science Education Standards.* Washington D.C.: National Academy Press.

Ogunmade, T. O. (2005). The status and quality of secondary science teaching and learning in Lagos State, Nigeria. Unpublished Ph.D. thesis, Faculty of Community Services, Education and Social Science, Edith Cowan University, Perth, Western Australia. Proquest, UMI Dissertations publishing.

Onuoha, J. C.; Ejimonye, J. C.; Eneogu, N. D. & Ugwuanyi, B. E. (2016). Effect of Concept Mapping Instructional Strategy on Students' Achievement and Interest in Economics in Secondary Schools in Enugu Education Zone. *Transylvanian Review,* **24** (8): 1222-1230.

Ozoji, B. E. (2013). Effects of Concept Mapping Technique on Students' Cognitive Development in Nigeria: Implications for Science and Technology Instruction PhD Thesis Submitted to the Department of Science and Technology Education, University of Jos, Nigeria.

Roth, W. M. (1993). Concept-Mapping in Primary Science. *Prime Areas*, **35** (3): 35-39.

Sambo, A. A. (2005). *Research Methods in Education*. Lagos, Stirling Horden Publishers (Nig) Ltd.

Shaibu, A. (2014). Navigating the Maze of Students' Underachievement in Science: Does Science Education Research Provide a Road Map? *Inaugural lecture series* at Ahmadu Bello University, Zaria. A.B.U Press Limited, Zaria.

Soleimani, H. & Nabizadeh, F. (2012). The Effect of Learner constructed. Fill-in-the-map Technique and Summarizing Strategy on Iranian pre-university students reading comprehension. *English Language Teaching*, **5** (9): 78-87.

Sparks-Linfield, R. & Warwick, P. (2003). "Is it like the school bus?" Assessment in the early years. In D. Whitebread (Ed), *Teaching and learning in the early years*. London: Routledgefalmer. 117-136.

Van-Merrienboer, J. G. (1990). Strategies for programming instruction in high school: Program Completion vs. Program Generation. *Journal of Educational Computing Research*, **6**: 265-287.

Wang, C. X. & Dwyer, F. M. (2006). Instructional Effects of Three Concept Mapping Strategies in Facilitating Student Achievement. *International Journal of Instructional Media*, **33**: 135-151.

Wilmut, J. & Yakasai, M. I. (2006). A brief review of the assessment of student achievement in Kaduna, Kano and Kwara states of Nigeria. DFID/World Bank SESP Preparation Mission. *esspin.org/reports*.