EFFECTS OF CONCEPT MAPPING INSTRUCTIONAL STRATEGY ON STUDENTS’ ACHIEVEMENT IN NUMBER AND NUMERATION IN KOGI STATE

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ABSTRACT
This study examined the effects of concept mapping instructional strategy on students’ achievement in number and numeration in Kogi State. Three hypotheses were formulated to guide the study. The study employed the quasi–experimental research design involving the non-equivalent pretest, posttest, control group design. The study population comprised 12,530 senior secondary II students from public secondary schools in Kogi State for the 2016/2017 academic session. A sample of 120 senior secondary II students from two secondary schools in Kogi Local Government Area of Kogi State was used for the study. Data were collected using Number and Numeration Achievement Test (NANAT). Analysis of Covariance (ANCOVA) was used to test the hypotheses formulated at 0.05 alpha level. Results revealed that there was significant effect of concept mapping instructional strategy on students’ achievement in number and numeration \(F_{(1,115)} = 239.647; P = 0.000\). However, there was no significant effect of sex on students’ achievement in number and numeration \(F_{(1,115)} = 0.045; p = 0.832\). Likewise, there was no significant interaction effect of treatment and sex on students’ achievement in number and numeration \(F_{(1,115)} = 0.790; p = 0.376\). Based on these findings, it was concluded that concept mapping instructional strategy was more effective in enhancing students’ achievement in number and numeration than conventional instructional strategy. Therefore, the study recommended that Kogi State Ministry of Education should formulate policies that will mandate senior secondary school teachers to use concept mapping instructional strategy to enhance students’ achievement in number and numeration among others.

Keywords: Concept mapping, Instructional strategy, Number and numeration, Students’ achievement
INTRODUCTION

Mathematics is globally acknowledged as the bedrock of scientific and technological development. Nations that are seemed to be developed and largely considered as civilized have achieved this status through effective mathematics education for their citizens. Sule, Garba, and Haruna (2016) posited that the increasing importance and attention given to mathematics stems from the fact that without science there is no modern technology and without modern technology, there is no modern society. In other words, mathematics is the precursor and cornerstone of science and technology as well as indispensable single factor required in modern societal development. Eguavon (2002) described mathematics as the pivot of all civilizations and technological development. Corroborating this, Okafor (2005) posited that mathematics is an indispensable tool for development of science and technology. This implies that no nation can develop scientifically and technologically without proper foundations in school mathematics. This informed the inclusion of mathematics as one of the core subjects to be offered by all students up to senior secondary and tertiary levels of education among science and technology courses.

In spite of the importance of mathematics in nation building, scientific and technological development, it is still notable that students’ achievement at external examinations in Nigeria has remained considerably poor. The West African Examination Council (WAEC) Chief Examiner’s Reports (2013-2016) revealed that less than 62 percent of the students who sat for WASSCE between 2010 and 2015 in Nigeria passed mathematics at credit level. The situation is the same in Kogi State as analysis of school certificate mathematics examination results shows that less than 60 percent of the candidates who sat for WASSCE between 2010 and 2015 in Kogi State passed general mathematics at credit level and above (Kogi State Ministry of Education (KOSMOE), 2017). The current state of affairs is displeasing and this trend could hamper meaningful development in Nigeria and Kogi State in particular. Students’ poor performance over the years has been attributed to teachers’ use of inappropriate teaching methods which make students become passive and have less interaction with one another in doing task (Zakaria, Solfitri, Daud & Abidin, 2012). Similarly, WAEC (2015) posited that current results show that the conventional teaching approach is deficient in meeting the needs of majority of learners. According to Nzeadibe (2016), the WAEC Chief Examiner’s Report (2013-2014) emphasized on the need to improve teaching methods to enhance students’ achievement in mathematics. The consistent poor achievement of students’ in mathematics could also be attributed to learning difficulty among students. This is in line with the WAEC Chief Examiner’s Report which revealed that students have common learning difficulties in senior secondary mathematics themes of number and numeration, algebraic processes,
geometry, statistics and introductory calculus (Wonu & Zalmon, 2017). Since students’ poor achievement in number and numeration is placed at the door of inappropriate teaching method, the onus lies on the teacher to explore innovative methods such as concept mapping that could enhance students’ achievement in number and numeration.

According to Brinkerhoff and Booth (2013), a concept map is a schematic device for representing the relationships among a set of concepts. Jacob, Joel, Sababa and Ndatuwong (2016) posited that concept maps are forms of graphical organizers which allow students to perceive the relationships between concepts through diagrammatic representation of concepts using keywords. Salleh (2013) opined that concept mapping is a technique that arranges knowledge in a form of connected nodes. According to Nworgu (2012), concept mapping means a diagrammatic representation of concepts using arrows to indicate their relationship in order to represent a new knowledge structure. It involves visual representation of the structure of information, concepts, and their relationship. Visualizing knowledge is an approach where a subject with non-visual content is represented by graphics, diagrams or other represented or recognizable forms. Teaching through concept mapping has long lasting effect on memory demonstrated in the form of better results in delayed post-test as compared with other teaching/learning strategies (Ahmad & Munawar, 2013). According to Singh and Moono (2015), there are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links. Ajaja (2009) postulated that the principle of a concept map is that it provides a visual means of showing connections and relationships between hierarchies of ideas ranging from the very concrete to the abstract. Thus, concept map helps students to organize concepts into hierarchies. Concept maps are instructional tools that serve as means of developing logical thinking and study skills by revealing connections and helping learners see how individual ideas or concepts form a larger whole. Concept mapping-based instruction is one of the instructional strategies advocated by CEMASTER as learner-centred approach (Makoba, 2016).

Achievement is the outcome of education to which a student, teacher or institution has been able to realize their educational goals (Ezeudu, 2006). Achievement implies something that somebody has done successfully especially using his/her own efforts and skills (Okeke, 2016). Adeyemi (2008) described achievement as the scholastic standing of a student at a given moment which states individual ability. It refers to a person’s learning ability which could result in positive or negative performance. Bitrus (2014) stated that achievement is a measure of knowledge gained through education process usually indicated by test scores, grade point average and degree. Achievement is used to measure the state of a students’ cognitive, affective
and psychomotor domain. Student achievement can be explained in form of scores obtained from tests or examinations on courses taken. Research evidences revealed that the concept mapping instructional strategy positively impact on students’ achievement in mathematics (Adeneye, 2011; Nwoke, Iwu & Uzoma, 2015; Hafiz, Kadir & Maifalinda, 2017). Also concept mapping instructional strategy enhanced students’ achievement in specific areas of mathematics such as geometry (Sule, Garba, & Haruna, 2016) and trigonometry (Bot & Eze, 2016; Imoko, 2017). It is not known if the same success would be recorded in number and numeration. It was against this background that the present study examined how the concept mapping instructional strategy would affect students’ number and numeration achievement in Kogi State.

Gender is one of the variables to be considered in this study. Gender refers to the socially, culturally constructed characteristics roles which are ascribed to male and female in any society (Erinosho, 2005; Okeke, 2008). According to Opre and Opre (2005), gender means broad categories that reflect our impressions and beliefs about females and males. It refers to a set of categorical beliefs regarding the characteristic attributes of a person (men and women) based on his or her belonging to one of the two genders. Afonja (2002) defines gender as a socially constructed concept based on the assumed position that a group of humans should possess. Although some researchers have found that there are no significant differences in male-female mathematics performance at any level, most have identified gender differences (Atovigba, 2012). According to Bot and Eze (2016), gender was a significant factor on students’ achievement in mathematics when taught using concept mapping. However, Nwoke, Iwu and Uzoma (2015) reported that concept mapping instructional strategy removed gender inequality in students’ mathematics achievement. The contradictory results on gender informed its inclusion in this study as a moderator variable. Thus, the study investigated the effect of gender on students’ achievement in number and numeration when taught using concept mapping instructional strategy.

**STATEMENT OF THE PROBLEM**

The knowledge of mathematics particularly number and numeration is very important to the extent that without it, there can be no meaningful development in science and technology, because it is the precursor of scientific discoveries and inventions. Mathematics is one of the core courses in secondary school and a prerequisite for the study of all science, technology and social science-based courses in tertiary institution as required by the Joint Admission and Matriculation Board (JAMB). Despite the recognition accorded mathematics due to its relevance, the achievement of students in standardized examination is appalling. Many students in the secondary school in Nigeria and Kogi State in particular often experience difficulties in
understanding, assimilating, retaining and applying mathematics concepts in solving practical problems most especially those dealing with number and numeration.

The deplorable state of mathematics achievement is attributed to a number of factors such as instructional strategies, instructional resources and attitude of students among others. Though many factors could affect students, achievement in number and numeration, one factor over which schools have the most immediate control is the choice of instructional strategies. It therefore, behoves on mathematics teachers in Kogi State to continue to search for new and relevant teaching strategies that could help their students to learn and achieve better results and to develop genuine interest in the number and numeration. Thus, the thrust of this study was to assess the effects of concept mapping instructional strategy on students’ achievement in number and numeration in Kogi State.

OBJECTIVES OF THE STUDY

The general aim of this study was to examine the effect of concept mapping learning strategy on students’ achievement in number and numeration in Kogi State.

Specifically, the objectives of the study were to:
1. ascertain the main effect of treatment on students’ achievement in number and numeration.
2. determine the main effect of gender on students’ achievement in number and numeration.
3. explore the interaction effect of concept mapping instructional strategy and gender on students’ achievement in number and numeration.

RESEARCH QUESTIONS

The following research questions guided the study:
1. What is the effect of instruction in concept mapping on senior secondary II students’ achievement in number and numeration in Kogi State?
2. To what extent will gender affect senior secondary II students’ achievement in number and numeration in Kogi State?
3. What is the interaction effect of concept mapping instructional strategies and gender on senior secondary II students’ achievement in number and numeration in Kogi State?

HYPOTHESES

The following hypotheses were postulated and tested at 0.05 alpha level:

\( H_{01} \): There is no significant effect of concept mapping instructional strategy on students’ achievement in number and numeration

\( H_{02} \): There is no significant effect of gender on students’ achievement in number and numeration
**Ho:** There is no significant interaction effect of concept mapping instructional strategy and gender on students’ achievement in number and numeration

**METHODOLOGY**

The study employed quasi–experimental research design involving the non-equivalent pre-test, posttest, control group design. Quasi experimental research design was considered suitable for the study because subjects were not randomly assigned to groups rather intact classes were assigned to experimental and control groups and were used for the study. The choice of this design is in agreement with the views of Nworgu (2015) and Uzoechi (2015, p.40) that “such designs in which intact or pre-existing groups are used where random assignment of subjects to the experimental and control groups is not possible is called quasi-experimental design”. The study population comprised 12, 530 SS II students from public secondary schools in Kogi State for the 2016/2017 academic session. A sample of 120 Senior Secondary II students from two secondary schools in Kogi Local Government Area of Kogi State was used for the study.

To obtain the study sample, Kogi State was clustered into three (eastern, western and central) senatorial districts. Then one (Western) senatorial district was randomly selected out of the three senatorial districts by lucky dip. Then the western senatorial district was clustered into seven local government areas (LGAs). Then one (Kogi) LGA was randomly selected out of the seven LGAs by lucky dip. Then two secondary schools (GSSS Koton Karfe and CSS Gegu-Beki) were randomly selected from Kogi LGA by lucky dip. Then senior secondary II intact classes in each of the two secondary schools selected were randomly assigned to experimental group (E) and control group (C) and were used for the study. Specifically, the two intact classes in Government Secondary School, Koton Karfe were randomly assigned to experimental group and the intact class in CSS Gegu-Beki was randomly assigned to control group. Consequently, the experimental group was exposed to the use of concept mapping while the control group was exposed to the use of conventional instructional strategy.

Data for the study were obtained using a 50 items Number and Numeration Achievement Test (NANAT). The construction of NANAT items was based on three topics (logarithms, arithmetic progression and geometric progression) drawn from SS II curriculum. The researchers also developed research tools which served as guide for the conduct of the experiment. Content validity was ensured in NANAT by developing a table of specification. Face validity was obtained for NANAT and the research tools by subjecting them to critical appraisal of two research experts in faculty of education, Kogi State University, Anyigba. Reliability of the instruments was established by using Cronbach Alpha method of estimating coefficients of internal consistency. The reliability coefficient of 0.85 was obtained for
NANAT. The instrument (NANAT) was administered on the subjects as pretest and posttest. The two groups (experimental and control) were made to cover the same learning contents (logarithms, arithmetic progression and geometric progression). However, the experimental group was exposed to the contents using concept mapping instructional strategy while the control group was taught using conventional instructional strategy. The study lasted for a period of four weeks with the involvement of two research assistants that were properly trained in the use of the instruments. The research assistants were the regular SS II mathematics teachers from the public secondary schools selected for the study. Pretest was administered on the two groups before the commencement of treatment. After the treatment, NANAT items were reshuffled and administered on the subjects as posttest. Analysis of Covariance (ANCOVA) was used to test the hypotheses formulated at 0.05 alpha level.

RESULTS

Hypothesis 1

There is no significant effect of concept mapping instructional strategy on students’ achievement in number and numeration.

The null hypothesis 1 was tested and the results obtained are presented in Table 1:

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>9094.870 (^a)</td>
<td>4</td>
<td>2273.718</td>
<td>71.655</td>
<td>0</td>
</tr>
<tr>
<td>Intercept</td>
<td>4779.851</td>
<td>1</td>
<td>4779.851</td>
<td>150.635</td>
<td>0</td>
</tr>
<tr>
<td>PRETEST</td>
<td>45.793</td>
<td>1</td>
<td>45.793</td>
<td>1.443</td>
<td>0.232</td>
</tr>
<tr>
<td>GROUP</td>
<td>7604.29</td>
<td>1</td>
<td>7604.29</td>
<td>239.647</td>
<td>0</td>
</tr>
<tr>
<td>SEX</td>
<td>1.44</td>
<td>1</td>
<td>1.44</td>
<td>0.045</td>
<td>0.832</td>
</tr>
<tr>
<td>GROUP * SEX</td>
<td>25.055</td>
<td>1</td>
<td>25.055</td>
<td>0.79</td>
<td>0.376</td>
</tr>
<tr>
<td>Error</td>
<td>3649.097</td>
<td>115</td>
<td>31.731</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>318572</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>12743.97</td>
<td>119</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Analysis of Covariance (ANCOVA) summary in Table 1 shows that students in the two groups used for the study demonstrated similar ability in number and numeration prior to the experiment (F\(^{(1,115)}\) = 1.443; P = 0.232). However, the result in Table 1 shows that there is a significant main effect of treatment on students’ achievement in number and numeration (F\(^{(1,115)}\) = 239.647; P = 0.000). This result suggests a statistically significant difference between
the mean achievement scores of students’ taught number and numeration using concept
mapping instruction strategy and those taught using conventional instruction strategy.
Therefore, the null hypothesis is rejected. This implies that the experimental group performed
significantly better than the control group after the treatment. Thus, concept mapping
instructional strategies provided favourable effects on the experimental group and the effect
led to significant improvement in students’ achievement in number and numeration.

**Hypothesis 2**

There is no significant effect of gender on students’ achievement in number and
numeration.

The result presented in Table 1 shows that there is no significant main effect of sex on
students’ achievement in number and numeration (F(1,115) = 0.045; p = 0.832). This indicates
that the differences between mean achievement scores of male and female students’ taught
number and numeration using concept mapping instructional strategy and the control group is
statistically insignificant.

**Hypothesis 3**

There is no significant interaction effect of concept mapping instructional strategy and
gender on students’ achievement in number and numeration.

The result presented in Table 1 shows that there is no significant interaction effect of
treatment and gender on students’ achievement in number and numeration (F(1, 115) = 0.790;
p = 0.376). This implies that the interaction effect of treatment and gender on mean
achievement scores of students’ taught number and numeration using concept mapping
instructional strategy and the control group is statistically insignificant.

**DISCUSSION**

The study revealed that the achievement of students taught number and numeration
using concept mapping instructional strategy was significantly higher than those taught using
conventional instructional strategy. This concurs with the findings of Adeneye (2011); Nwoke,
Iwu and Uzoma (2015); Hafiz, Kadir and Maifalinda (2017) who reported that there was
statistically significant difference between the achievement of students taught mathematics
using concept mapping instructional strategy and those taught using conventional instructional
strategy. Similarly, the result agrees with earlier findings in specific areas of mathematics such
as trigonometry and geometry (Bot & Eze, 2016; Imoko, 2017; Sule, Garba & Haruna, 2016).

Findings from this study revealed that gender does not significantly affect the mean
achievement scores of students’ taught number and numeration using concept mapping
instructional strategy and those taught using conventional instructional strategy. This concurs
with the findings of Nwoke, Iwu and Uzoma (2015) who reported that the difference between
the achievement of male and female students in mathematics was statistically insignificant. However, the finding is incongruent with that of Bot and Eze (2016) who reported that there was statistically significant difference between the achievement of male and female students in mathematics. Furthermore, findings from this study revealed that there was no significant interaction effect of treatment and sex on students’ achievement in number and numeration.

CONCLUSION

In view of the findings of this study, the following conclusions were drawn: concept mapping instructional strategy was effective in enhancing students’ achievement in number and numeration than conventional instructional strategy. The effect of sex on students’ achievement in number and numeration when taught using concept mapping instructional strategy was statistically inconsequential.

RECOMMENDATIONS

Based on the findings of this study, the followings are recommended:

1. Kogi State Ministry of Education should formulate policies that will mandate teachers to use concept mapping instructional strategy in the teaching of number and numeration in Senior Secondary Schools to enhance the achievement of students.

2. Mathematics teachers should endeavour to make use of concept mapping instructional strategy so as to improve the achievement of students in the concepts.

3. Mathematics teachers should expose both male and female students to concept mapping instructional strategy in order to eliminate sex related differences in students’ achievement in number and numeration.

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