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EFFECT OF PLAY-LEARN-ACT-NOW GAME AND CONCEPT MAPPING INSTRUCTIONAL STRATEGIES ON STUDENTS' INTEREST IN BASIC SCIENCE CLIMATE CHANGE CONCEPTS

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Abstract

This study investigated the effects of the Play-Learn-Act-Now (PLAN) game and concept mapping instructional strategies on students' interest in Basic Science climate change concepts. Three research questions were answered while three hypotheses tested at 0.05 level of significance. The research adopted a non-equivalent pre-test post-test, non randomised, quasi experimental design. The population consists of 5,773 (2,063 males and 3,710 females) upper basic 3 students from 162 upper basic co-educational schools. The sample comprised 188 (92 males and 96 females) Upper Basic 3 students from two upper basic co-educational schools selected using multi-stage sampling procedure. Students' Interest in Climate Change Questionnaire (SICCQ) was used to collect data. After face validity, reliability of SICCQ was computed using Cronbach Alpha method and it yielded 0.87. Trained research assistants (Basic Science teachers in sampled schools) taught students in experimental and control groups. The period used for data collection was seven weeks. Mean and standard deviation were used to answer research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA) statistic. Findings showed that there was no significant difference between the mean interest ratings of students taught climate change concepts using PLAN game instructional strategy and those taught using concept mapping instructional strategy in Basic science ($F(2,185) = 1.436$; $p = 0.232 > 0.05$); there was a significant effect of PLAN game instructional strategy on male and female students' mean interest ratings in climate change concepts in Basic science ($F(2,94) = 7.790$; $p = 0.006 < 0.05$; there was a significant effect of concept mapping instructional strategy on students' mean interest ratings in climate change concepts in Basic science based on gender ($F(2,88) = 12.700$; $p = 0.001 < 0.05$). It was recommended among others that, Basic Science teachers should adopt the use of PLAN game and concept mapping instructional strategies in the teaching of climate change concepts.

Key Words: Play-Learn-Act-Now game, concept mapping instructional strategy, students' interest, climate change gender and Basic science.

Introduction

Basic Science is a foundation and bedrock for the study of science at post-basic education level in Nigeria. It plays a pivotal role in shaping students' understanding of scientific principles. Ayua and Eriba (2023) noted that

Basic Science is designed to prepare students for the study of core science subjects such as Biology, Physics, and Chemistry at the senior secondary level, making it a crucial part of the educational system. Furthermore, Danjuma (2015) referred to Basic Science as a subject in which the concepts and principles of science are presented to express the fundamental unity of scientific thought and to avoid premature or undue stress on the distinctions among the scientific fields. It is vital for academic success in diverse fields ranging from engineering to medicine and the natural sciences at the tertiary level. This is made possible by the integration of content from the various sciences of Biology, Chemistry and Physics and space science which could empower students to live effectively in the global community and contribute in solving global problems.

One of the world's dreading phenomena is the effect of global warming as a result of climate change. Climate is a complex natural process that involves the interaction of the air, the water, and the land surface (Palmetto, 2021). The atmosphere is mostly nitrogen and oxygen, but it also contains smaller amounts of other gases, including those commonly referred to as 'greenhouse gases'. Greenhouse gases include carbon dioxide (CO_2), methane, nitrous oxide, chlorofluorocarbons and water vapour (Schaller, 2016). Climate change is the long-term increase in the earth's average surface temperature and the large-scale changes in global, regional, and local weather patterns that result from that increase, caused by a significant increase in the levels of greenhouse gases that are produced by the use of fossil fuels (Palmetto, 2021).

Benue State is located in Central Nigeria and it has suffered localised impacts of climate change most notably seasonal flashfloods due to increasing intensity of torrential rainfall resulting in displacements, destruction of farmlands and interruption of learning in especially basic education schools which are often used as temporary camps for displaced persons. A 2024 flood situation report for Benue State by the International Oganisation for Migration (IOM, 2024) in partnership with the Benue State Emergency Management Agency (BENSEMA) highlighted that children between 1 and 17 years, the age group of children at the basic education level, represent a significant portion of the population requiring attention to their educational and nutritional, among other needs. The report highlighted that Makurdi LGA had the highest number of affected persons with 46% of the affected population. Historically, Makurdi LGA has suffered the impacts of flooding notably the 2012 and 2022 floods yet, the report did not highlight education as a first line intervention despite its centrality in addressing the root cause of flooding. Affirming the author's observation, Ronald, Merab, and Byalusaago (2017) lamented that African countries scantily infuse climate change content in their educational curriculums. Owolabi, Gyimah, and Amponsah (2012), and Boakye (2015) decried the poor integration of climate change in pre-tertiary curricula of the Ghanaian education system. In Nigeria, Eze, Nwagu, and Onuoha (2022) lamented that climate change is only explicitly included as a topic within the Geography curriculum. On a brighter note, Onuoha, Eze, Ezeaputa, Okpabi, and Onyia (2021) reported that other science subjects such as Agricultural science, Biology and Chemistry contain topics that could initiate discussions on climate change. Though not expressly stated, the Basic Science Curriculum (NERDC, 2024) contains topics such as flooding, soil erosion, desertification, deforestation and ozone layer depletion among others that could influence students' interest. These topics are discussed as Environmental Education (EE) topics under which climate change is subsumed.

Interest in an activity, such as learning, could most probably be a very powerful affective psychological trait. Kpolovie, Joe and Okoto (2014) viewed interest as very strong knowledge emotion as well as an overwhelming magnetic positive feeling, a sense of being captivated, enthralled, invigorated and energized to cognitively process information much faster and more accurately. In the opinion of Matsum (2017), interest is a positive feeling that motivates a learner to have a propulsion, or being energised in learning. Interest simultaneously diversifies their experience and focuses their experiences, leading them to pay attention to only certain things and not to some other things that tend to stimulate their attention (Paul, 2013). Interest serves as a drive towards the new, the edgy, and the exotic. Both the urge to approach or engage in certain events and the urge to avoid some events lie in the realm of interest. The adoption of innovative instructional strategies could lead to the development of students' interest. Teacher's ability to arouse student interest is essential for higher performance in Basic Science. Research findings indicate that game-based and concept mapping instructional strategies have potential to enhance students' interest (Oviawe & Lukmon, 2017; Ojo, 2021; Okardi & Ebikebuna, 2022). Thus, the current study investigated the effect of the Play-Learn-and-Act-Now and concept mapping instructional strategies on students' interest in climate change concepts.

The Play-Learn-Act-Now (PLAN) game is an environmental education card game developed by Ecocykle Development Foundation and launched in 2023. The game is specifically designed for young people; hence, it is made for students at the Basic education level. Broadly, the game enables players to identify problems and solutions to an array of environmental issues in which climate change is embedded. These issues or concepts include flooding, desertification, gas flaring, plastic pollution, deforestation, ozone layer depletion and oil spillage among others. Though the game has traditional rules guiding its play, the current study has adopted and adapted the steps to suit the context of this study. With this procedure, the Basic Science teachers can ensure effective and efficient presentation of facts and ideas of climate change to ensure students develop interest, improve performance and retention of climate change concepts. This will promote interaction among students, ensure that lessons are knowledge-based, activity-oriented and student centered for meaningful learning, enhanced understanding and sense making of concepts learnt. Research findings in other locations indicate that card games are effective in enhancing students' learning gains (Liu & Chena, 2013; Bankole, 2018; Selvi & Çoşan, 2018; Septanie, 2019; Mahardika & Putra, 2020; Lawsin, 2023;). However, this study is necessitated by the fact that there is scarcity of research in literature in the study area on effects of PLAN card game on students' interest in climate change concepts to the best of the knowledge of the researcher.

Another innovative instructional strategy considered in this study is concept mapping. Concept mapping originated from concept maps and was developed in 1972 by Novak and associates at the Cornell University (Enebechi & Nzewi, 2021). Novak and Gowin (1984) opined that a concept map is a schematic device used to represent a set of concept meanings embedded in a framework of propositions, a two-dimensional hierarchical diagram which clearly shows the interconnection between and among

individual concepts. Ullah, Munir and Ahmad (2021) stated that concept mapping is an instructional strategy that teachers employ for facilitating students learning. A concept map is a pedagogical/metacognitive tool, a diagram showing the relationships among concepts designed to help students learn how to learn (Novak, 1998). Concept mapping has been adequately advocated in literature as a strategy for meaningful learning of abstract concepts and assists students to learn about conceptual changes (Novak, 1990; Kpiranyam, Achor & Fakaa, 2024). The use of this tool in teaching abstract concepts may be observed as a paradigm shift. It is a graphical tool for organising and representing knowledge and a valuable resource with organizing and structuring knowledge. Conceptual maps enable students to represent their understanding of domain knowledge in a well-organised format which may stimulate male and female students' interest.

Gender as a factor can influence students' interest in learning with particular regard to science education. Nzewi in Agernor (2016) conceived gender as a sense of awareness of being male or female and the roles that are attached to each group in the society. Gender is a personal conception of oneself as male or female, a strong predictor of human conduct and it may influence students' behaviour, interest, performance and retention in an academic activity. Illiyas & Aron (2017) noted that these factors relate with the gender, learning and teaching situations. Gender therefore, is a psychological term and a cultural construct developed by society to differentiate the roles, behaviour, mental and emotional attributes of males and females. Studies on gender continue to yield a mixed bag of findings. Okechukwu and Opara (2021) found that gender has significant difference in interest of students exposed to Basic Science and Technology using team teaching strategy in favour of boys. However, Baba, Jumma and Zachariah (2022) found no significant gender difference in the interest of students in Basic Science. The researchers sought to investigate the effect of PLAN game and concept mapping instructional strategies on students' interest in climate change concepts in Basic Science. The study also examined the effect of PLAN game instructional strategy on male and female students' interest in climate change concepts in Basic Science.

Research Questions

The following research questions were raised to guide the study.

1. What is the difference between the mean interest ratings of students taught climate change concepts using PLAN game and concept mapping instructional strategies in Basic Science?
2. What is the difference between the mean interest ratings of male and female students taught climate change concepts using PLAN game instructional strategy in Basic Science?
3. What is the difference between the mean interest ratings of male and female students taught climate change concepts using concept mapping instructional strategy in Basic Science?

Hypotheses

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

1. There is no significant difference between the mean interest ratings of students taught climate change concepts using PLAN game instructional strategy and those taught using concept mapping instructional strategy in Basic Science.
2. There is no significant difference between the mean interest ratings of male and female students' taught climate change concepts using PLAN game instructional strategy in Basic Science.

3. There is no significant difference between the mean interest ratings of male and female students taught climate change concepts using concept mapping instructional strategy in Basic Science.

Research Method

The research adopted a non-equivalent pre-test post-test, non randomised, quasi experimental design. The reason for adopting quasi-experimental design is because the school schedule was not disrupted or classes reorganised for the conduct of the study therefore, intact classes were used. Emaikwu (2015) supports the use of non-equivalent control group design when it is not possible to randomize as in true experiments. The population of the study consisted of 5,773 (2,063 males and 3,710 females) Upper Basic 3 students in all public co-educational schools in Benue State in the 2023/24 academic session (Benue State Teaching Service Board, Makurdi, 2024). The sample comprised 188 (92 males and 96 females) upper basic 3 students from two upper basic co-educational schools selected using multi-stage sampling procedure. The Students' Interest in Climate Change Questionnaire (SICCQ) developed by the researcher contained two sections, A and B. Section A demanded information on gender and name of school. Section B measures students' interest in climate change in Basic Science (See Appendix B, p.120). The response mode will be Strongly Agree (SA) 4 points, Agree (A) 3 points, Disagree (D) 2 points and Strongly Disagree (SD) 1 point. The respondents were instructed to place a tick (√) on items of the instrument based their level of agreement or disagreement as it best applied to them. The aggregate mean ratings were analysed to ascertain the effectiveness of the strategies on students' interest in climate change concepts. To determine both face and content validity, the instrument was presented to five experts; two Professors of Science Education, a Senior Lecturer/Basic Science expert and a Senior Lecturer in Mathematics Education in the Department of Science and Mathematics Education, Benue State University, Makurdi.

The instrument was also presented to a Professor of Measurement and Evaluation at the Joseph Sarwuan Tarka University, Makurdi. The experts assessed the instruments. All corrections were incorporated to improve the quality of the instruments. The reliability of SICCQ was computed using Cronbach Alpha method and yielded reliability coefficient of 0.87. The researcher visited the two sampled schools and obtained permission from principals of the schools. The research assistants were trained on how to conduct the experimental conditions before the commencement of the experiment. The period used for data collection was seven weeks in the second term of the 2024/2025 academic session. In the first week, the research assistants were trained and the SICCQ was administered as pre-test to all the groups. Treatment commenced in the same week and lasted for five weeks. While the SICCQ was administered in the fifth week as post-test. Each class session lasted 80 minutes per week. To answer research questions, mean, standard deviation and bar chart were used. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA) statistic. The decision rule was that the null hypothesis is rejected if p-value is less than 0.05, otherwise it is not rejected.

Results

The results are presented according to the research questions and hypotheses that guided the study.

Research Question One

What is the difference between the mean interest ratings of students taught climate change concepts using PLAN game and concept mapping instructional strategies in Basic Science?

Table 1: Mean and Standard Deviation of Interest Ratings of Students Taught Climate Change Concepts in Basic Science Using PLAN Game and Concept Mapping Instructional Strategies

Group		Pre-Test		Post-Test		Mean
	N	$\bar{x}$	SD	$\bar{x}$	SD	Gain
PLAN Game Strategy	97	2.68	0.36	2.87	0.28	**0.19**
Concept Mapping Strategy	91	2.74	0.34	2.82	0.33	**0.08**
Mean Difference		**0.06**		**0.05**		**0.11**

Table 1 reveals that students taught climate change concepts in Basic science using PLAN game strategy had 2.68 and 2.87 as pre-test and post-test mean interest ratings with standard deviation of 0.36 and 0.28 respectively, while students taught using the concept mapping strategy had pre-test and post-test mean interest ratings of 2.74 and 2.82 with standard deviation of 0.34 and 0.33 respectively. Result in the table shows that students taught Basic science using PLAN game strategy obtained the mean gain value of 0.19 while their counterparts taught using the concept mapping had mean gain value of 0.08. Students in the PLAN game group have a lower standard deviation of 0.28 at the post-test compared to 0.33 recorded in the concept mapping group. This signifies that the interest ratings of students taught using PLAN game are more homogenous. The mean gain difference was 0.11 in favour of students taught using PLAN game strategy.

Research Question Two

What is the difference between the mean interest ratings of male and female students taught climate change concepts using PLAN game instructional strategy in Basic Science?

Table 2: Mean and Standard Deviation of Interest Ratings of Male and Female Students Taught Climate Change Concepts in Basic Science Using PLAN Game Instructional Strategy

Gender		Pre-Test		Post-Test		Mean
	N	$\bar{x}$	SD	$\bar{x}$	SD	Gain
Male	46	2.67	0.36	2.79	0.31	**0.12**
Female	51	2.69	0.36	2.95	0.24	**0.26**
Mean Difference		**0.02**		**0.16**		**0.14**

Table 2 shows that the mean interest ratings of male and female students taught climate change concepts in Basic science using PLAN game instructional strategyis2.67 and 2.79inpre-test and post-test with Standard deviation of 0.36 and 0.31. Female students in the same group have pre-test and post-test mean ratings of 2.69 and 2.95 with standard deviation of 0.36 and 0.24 respectively. Result in the table further establishes mean gain of 0.12 and 0.26 for the male and female students with a mean gain difference of 0.14 in favour of female students. The standard deviation of 0.24 recorded by female students in post-test indicates that the ratings have less outliers compare those of male students with a value of 0.31.

Research Question Three

What is the difference between the mean interest ratings of male and female students taught climate change concepts using concept mapping instructional strategy in Basic Science?

Table 3: Mean and Standard Deviation of Interest Ratings of Students Taught Climate Change Concepts in Basic Science Using Concept Mapping Instructional Strategy based on Gender

Gender		Pre-Test		Post-Test		Mean
	N	$\bar{x}$	SD	$\bar{x}$	SD	Gain
Male	46	2.69	0.36	2.70	0.33	**0.01**
Female	45	2.79	3.11	2.94	0.30	**0.15**
Mean Difference		**0.32**		**0.14**		**0.14**

Table 3 shows that the mean interest ratings of male students taught climate change concepts in Basic science using concept mapping instructional strategy is 2.69 with a standard deviation of 0.36 in the pre-test and 22.70 with a standard deviation of 0.33 in the post-test. The mean interest ratings of female students taught climate change concepts in Basic science using concept mapping instructional strategy is 2.79 with a standard deviation of 3.11 in the pre-test and 2.94 with a standard deviation of 0.30 in the post-test. Table 7 further shows that the mean gain in interest of male students is 0.01 while that of female students is 0.15. The result further reveals that the mean difference of male and female students' interest is 0.14 in favour of female students. The standard deviation of 0.30 recorded by the female students in post-test indicates that their interest ratings have less variability compare to their male counterparts with a value of 0.33.

Hypothesis One

There is no significant difference between the mean interest ratings of students taught climate change concepts using PLAN game instructional strategy and those taught using concept mapping instructional strategy in Basic science.

Table 4: ANCOVA Result on Mean Interest Ratings of Students Taught Climate Change Concepts in Basic Science Using Plan Game and Concept Mapping Instructional Strategies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.155[a]	2	.078	.810	.446
Intercept	23.002	1	23.002	240.503	.000
Pre-Test	.027	1	.027	.281	.597
Group	.137	1	.137	1.436	.232
Error	17.693	185	.096		
Total	1541.155	188			
Corrected Total	17.848	187			

a. R Squared = .009 (Adjusted R Squared = -.002)

Table 4 indicates that F(2,185) = 1.436; p = 0.232>0.05. Since the probability level is greater than the specified alpha level of 0.05, the null hypothesis is not rejected. It implies that there is no significant difference between the mean interest ratings of students taught climate change concepts using PLAN game instructional strategy and those taught using concept mapping instructional strategy in Basic science. The R squared value of 0.009 for strategy implies that 0.9% of the difference in the students' interest ratings can be accounted for by the instructional strategies employed in teaching climate change concepts in Basic Science. This indicated a very small effect size.

Hypothesis Two

There is no significant difference between the mean interest ratings of male and female students' taught climate change concepts using PLAN game instructional strategy in Basic science.

Table 5: ANCOVA Result on Mean Interest Ratings of Male and Female Students' Taught Climate Change Concepts using PLAN game instructional Strategy in Basic Science

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.592[a]	2	.296	3.907	.023
Intercept	13.603	1	13.603	179.645	.000
Pre-Test	.000	1	.000	.003	.957
Gender	.590	1	.590	7.790	.006
Error	7.118	94	.076		
Total	807.698	97			
Corrected Total	7.709	96			

a. R Squared = .077 (Adjusted R Squared = .057)

Table 5 indicates that F(2,94) = 7.790; p = 0.006< 0.05. Since the probability level is less than the specified alpha level of 0.05, the null hypothesis is rejected. Thus, there is significant effect of PLAN game instructional strategy on male and female students' mean interest ratings in climate change concepts in Basic science. The R squared value of 0.077 for strategy implies that 7.70% of the difference in the male and

female students' interest ratings can be accounted for by the instructional strategy employed in teaching climate change concepts in Basic Science. This indicated a low effect size.

Hypothesis Three

There is no significant difference between the mean interest ratings of male and female students taught climate change concepts using concept mapping instructional strategy in Basic science.

Table 6: ANCOVA Result on Mean Interest Ratings of Male and Female Students Taught Climate Change Concepts Using Concept Mapping Instructional Strategy in Basic Science

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.296[a]	2	.648	6.543	.002
Intercept	10.533	1	10.533	106.356	.000
Pre-Test	.000	1	.000	.005	.946
Gender	1.258	1	1.258	12.700	.001
Error	8.715	88	.099		
Total	733.457	91			
Corrected Total	10.011	90			

a. R Squared = .129 (Adjusted R Squared = .110)

Table 6 indicates that F(2,88) = 12.700; p = 0.001< 0.05. Since the probability level is less than the specified alpha level of 0.05, the null hypothesis is rejected. By implication, there is significant effect of concept mapping instructional strategy on students' mean interest ratings in climate change concepts in Basic science based on gender. The R squared value of 0.129 for strategy implies that 12.9% of the difference in the male and female students' mean interest ratings can be accounted for by the instructional strategy employed in teaching climate change concepts in Basic Science. This indicated a low effect size.

Discussion of Findings

The study found that there was no significant difference in the mean interest ratings of students taught climate change concepts using PLAN game instructional strategy and those taught using concept mapping instructional strategy. This finding corroborates that of Ojo (2021) who found that Kahoot game enhanced students' interest. The finding is also in agreement with that of Okardi and Ebikebuna (2022) who found that concept mapping instructional strategy enhanced students' interest in Basic Technology. The finding is also in line with that of Oviawe and Lukmon (2017) who found that concept mapping enhanced students' interest. The finding however did not agree with that of Okonkwo and Samuel (2021) who found a significant difference in the mean interest rating of students taught using simulation game and concept mapping. Okonkwo and Samuel (2021) found that students exposed to simulation games significantly recorded higher interest gains as compared to the concept mapping and control groups. The finding that PLAN game and concept mapping

enhanced students' interest in climate change concepts in Basic Science is possible because students were captivated by the activities provided by the PLAN game instructional strategy which aroused their interest as they played and learnt at the same time. Similarly, the graphical visual-based representation of concepts in the concept mapping instructional strategy could arouse students' interest as they learn. This means that Basic Science students' interest could be improved if they are allowed to take charge of learning as shown in this study with the use of PLAN game and concept mapping.

In terms of gender, the study reported a significant difference in the mean interest ratings of male and female students taught climate change concepts using PLAN game instructional strategy in Basic Science. Female students recorded higher mean interest ratings compared to male students taught climate change concepts using PLAN game instructional strategy. This finding is in corroboration with the Ojo (2021) study which reported that female students taught with kahoot game recorded significantly higher interest ratings as compared to male students. This finding is however, not in agreement with earlier studies by Baba, Jumma and Zachariah (2022) which reported no significant difference in the mean interest ratings of male and female students. The finding that there exist a significant difference in the mean interest ratings of male and female students in favour of female students taught climate change concepts using PLAN game could be because female students were more captivated by the beautiful cards used in the PLAN game which aroused their interest and liking of the learning activity higher than their male counterparts. Naturally, females (girls) show more interest in beautiful and aesthetically appealing phenomena than males (boys). This postulation is in line with the assertion of Bulczak and Grzegory (2014) who posited that when male and females see something they think is beautiful, their brains react differently, with the female brain showing more activity than the male in such situations.

The study found a significant difference in the mean interest ratings of male and female students taught climate change concepts with concept mapping. Specifically, female students had higher mean interest ratings than male students. This finding affirms that of Okonkwo and Samuel (2021) who found a significant difference in the mean interest ratings of male and female taught with concept mapping. However, the finding is in contention with that of Oviawe and Lukmon (2017); Okardi and Ebikebuna (2022) who found no significant difference in the mean interest ratings of male and female students taught using concept mapping. The finding also disagrees with that of Baba, Jumma and Zachariah (2022) who found no significant difference in the mean interest ratings based on gender when concept mapping was used. This disagreement could be as a result of the variation in the research subjects and location.

Conclusion

Findings of this research indicate that, PLAN game and concept mapping instructional strategies equally improved students' interest in climate change concepts in Basic Science. In addition, PLAN game instructional strategy and concept mapping were gender bias in fostering interest.

Recommendations

From the findings of this study, the following recommendation are made:

1. Basic Science teachers should adopt the use of PLAN game and concept mapping instructional strategies in the teaching of climate change concepts.
2. Basic Science professional bodies such as STAN, should organise workshops on the effectiveness of PLAN game and concept mapping instructional strategies.

3. Nigerian Educational Research and Development Council (NERDC) and other relevant government agencies and non-governmental organisations should sponsor further researches to determine the efficacy of PLAN game and concept mapping instructional strategies on students' interest, performance and retention no a broader scale as it relates to male and female students' interest in Basic science.

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