Comparative Analysis of Early Childhood Care Education Pre-Service Teachers Performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity

Unamba, Eugene Chukwuemeka
Department of Primary Education Studies
Alvan Ikoku Federal College of Education, Owerri
Email: unambaeze@gmail.com

Dr Chinyere Oguoma
Department of Educational Psychology/G/C
Alvan Ikoku Federal College of Education, Owerri

Dr Duru D.C.
Department of Mathematics
Alvan Ikoku Federal College of Education, Owerri

DOI: 10.56201/ijee.v9.no8.2023.pg155.168

Abstract

The study investigated Comparative Analysis of Early Childhood Care Education Pre-Service Teachers Performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical creativity. Based on the purpose of the study two research questions and two hypotheses were formulated and tested at 0.05 level of significance. The study adopted a survey research design. The population for the study comprises 172 pre-service teachers in the school of early childhood care education. A sample size of 104 participants was used for the study involving24 males and 28 females for PPT while 23 males and 29 females in CBT examination. The instrument used for data collection was a Mathematics Creativity Test (MCT).The reliability of the test was ascertained using the Kuder-Richardson Coefficient and found to be 0.82. Data was analyzed using mean and standard deviation for the research question while t-test was used test the hypotheses. Results showed that Early Childhood Care Education Pre-Service Teachers perform better in CBT than PPT Examination in Mathematics irrespective of gender. It was recommended that Government should provide an enabling environment for Computerized testing Nigeria in Tertiary institutions.

Keywords: *Mathematics, Mathematical Creativity, Paper Pencil Test (PPT), Computer Based Test (CBT)*

Introduction

Mathematics is a means of developing logical and quantitative thinking abilities. Mathematics is also said to be an organized structure of knowledge that deals with the logic of quantity, shape or structure Egbo, Nnaji & Akujuba (2014). Odill in Unamba, Onyekwere and Ihekwaba (2016) revealed that mathematics is a collection of techniques and methods, the product of human activity and even the activity itself, namely the solving of problems. This is to say that mathematics is a subject and at the same time strategy for learning itself. Mathematics is the language and culture that is common to all disciplines (Nwoke, Nwaneri & Unamba, 2015). It is the wheel that moves science and research activities in today's technology globalization (Ugama,2009). Mathematics is seen as a language in which every symbol and every combination of symbols has precise meaning which can be determined by the application of logical rules. This language can be used to describe and analyze anything in the universe. Unodiaku (2013) noted that, it is the only core science subject that acts as a point on which national development and wealth of any nation is created. Mathematics is the study of numbers, counting and measurement, but that is only the beginning. Mathematics is the queen of science and tool for scientific and technological development, an indispensable tool for effective use of technology resources for national development (Nwoke, Nwaneri & Unamba, 2015). It is also a way to communicate ideas, and perhaps more than anything, it is a way of reasoning that is unique to human beings. Unamba, Ugochukwu & Ewunonu (2016) defined mathematics as the study of patterns and relationships which can be expressed in symbols. It embraces many important ideas, about number and space which involve problem solving as activities.

Mathematical creativity can be defined as the ability to produce original work that significantly extends the body of knowledge, and the ability to open avenues of new questions for other mathematicians (Jyoti, 2017). Norani & Noorjoharudden (2010) described mathematical creativity as an ability to analyze a given problem in many ways, observe patterns, see likenesses and differences, produce multiple ideas and decide upon a suitable method to tackle unfamiliar mathematical situation. Norani & Noorjoharudden (2010) outlined six different criteria for describing mathematical creativity. All the criteria have been identified as checking creative ability in mathematics. These include (i) the ability to formulate hypotheses in a mathematical situation, (ii) the ability to determine mathematical patterns in a mathematical situation, (iii) the ability to break from stereotype established mind sets, (iv) the ability to consider and evaluate unusual mathematical ideas, to think through their consequences for a mathematical situation, sensing what is missing from a mathematical situation and to ask questions that will enable one to fill in the missing mathematical information and (vi) the ability to split general mathematical problems into specific sub-problems. Mathematical creativity is the ability to generate ideas from given information.

Thus it is appropriate that students should at least be allowed to examine a wide variety of enrichment problems in mathematics. By providing divergent responses to unconventional questions and other problem-solving experiences, mathematical creativity can be explored to the fullest. According to (National Council of Teachers of Mathematics(2000), Mathematics

creativity requires six different resources in order to develop, including intellectual abilities, thinking styles, knowledge, personality, motivation, and environment.

Intellectual abilities are concerned with the ability to apply new perspectives to view things, assess ideas, promote ideas to others, and incorporate feedback. Intellectual abilities involve three types of skills applicable to creative thinking: (1) experiential ability (unconventional thinking and information processing in dealing with novel problems and demands); (2) componential ability (monitoring which ideas are valuable and which are not); and (3) contextual ability (promoting a fit between one's idea and the environment through communicating, taking feedback, revising, and selling one's ideas. Norani & Noorjoharudden, 2010). A person must employ all three skills in problem -solving to be genuinely creative. A person with only experiential ability (otherwise known as synthetic ability) can produce new and original ideas, but without an inspection process, may ignore the feasibility of the ideas. A person with only componential ability (otherwise known as analytical ability) can be a critical thinker to reason and analyze, but not in a creative way. A person with only contextual ability (otherwise known as practical-contextual ability) may be able to deliver ideas to others in an inspirational and persuasive manner, not because the ideas are of good quality but because the presentation is powerful. All these intellectual abilities required to be assessed through classroom examination.

Examinations improve teaching by helping the teacher's planning and consistent student's preparation. Examinations are not limited to measuring educational or societal objectives and needs but incorporate a way of coping with the educational system (Havens, 2017). Examination generally determines the extent to which educational objectives are achieved as well as the extent to which educational institutions serve the needs of the community and society (shah, 2017).

Rehmani (2018) explained that examinations play a significant role in determining what goes on in the classroom in terms of what, and how teachers teach and learners learn and can have impact on both teaching and learning. The rapid advancement of Information and Communication Technologies (ICT) in teaching and learning has shifted the paradigm from paper-pencil-based to computer-based system of examinations Uysal & Kuku (2019).The paper - pencil test (PPT) examination is the traditional paper and pen examination that requires students to write their answers. The paper examinations were given inside normal classroom venues with normal examination setup: adequately spacing the students and including two forms of the question paper to reduce/eliminate cheating cases while Computer-based test (CBT) examination is administered by computer or by other technology devices linked to the internet or World Wide Web most of them using multiple choice questions (MCQs), (Sorana-Daniela and Lorentz, 2007). There are many names and forms to computer-based testing: Computer Assisted Testing, Computerized Assessment, Computer Based Testing (CBT), Computer Aided Assessment (CAA), Computer Based Assessment (CBA), Online Assessment, E-Assessment and Web-Based Assessment and others.

Bodmann and Robinson (2004) defined computer- based examination as a type of assessment that provide opportunities to measure complex form of knowledge and reasoning that is not possible to engage and assess through traditional methods while Conole and Warburton (2005) explained that CAT items are written to test particular levels of ability they have the

potential to deliver more accurate and reliable results than traditional tests (Conole & Warburton, 2000). CBT is a mode of testing that acts as a catalyst for change and provides a base for change in the mode of learning, instruction and curricula in educational institutions (Scheuermann & Pereira, 2008). The Use of CBT as a summative assessment tool carries concrete practical and economic benefits because it provides the facility to test an immense number of student cohorts with the facility of automated marking of responses (Charman, 2017; Zakrzewski & Bull, 2005).

The use of CBTs has numerous benefits for both students, teachers, and educational systems. One such benefit is the real-time scoring and immediate feedback provided by CBTs (Jeong, 2012). With reduced grading time, teachers can increase their teaching time (Eid, 2005). The individualized student data generated from CBTs can facilitate teacher instruction to be more strategically directed to enhance individual student goals (Johnson & Green, 2006). Due to the ease at which they can be manipulated, numerous test versions can easily be created, thereby increasing test security (Bodmann & Robinson, 2004; Poggio, Glasnapp, Yang, & Poggio, 2005). Additionally, the ease with which these tests can be manipulated lends itself to increased student control over testing and a medium that is easier to individualize for testing accommodations for students with learning disabilities (Bodmann & Robinson, 2004; Flowers, Kim, Lewis, & Davis, 2011; Jeong, 2012). Finally, the move to CBTs provides a more cost-effective way to assess students, reducing paper costs, administration costs, and scoring costs (Jeong, 2012; Threlfall, Pool, Homer & Swinnerton, 2007).Pedagogical advantages on CBT include: providing fast and error-free feedback; repeatability of tests consisting of randomly-generated test items; unquestionable reliability and fairness; flexibility in the allocation of test timing and venue; and, direct responsibility for one's own learning and test-taking (Charman, 2017). Keeping records for item analysis and reliability of scoring (Gvozdenko & Chambers, 2007; Sanni & Mohammad, 2015; Singleton, Horne, & Thomas, 2013; Smith & Caputi, 2005; Tippins, 2011). moreover, the CBT offer enormous scope for innovations in testing and assessment (Bennett, 1998; Chatzopoulou & Economides, 2010) and measures the complex form of knowledge and reasoning which is not possible through traditional methods (Bodmann & Robinson, 2004).

Furthermore, the extant literature reported mixed results about the gender impact on the performance of the examinees. For example, Gallagher, Bridgeman, & Cahalan, (2000) and Leeson, (2006) asserted the existence of gender effect on examination mode. Also, Oduntan, Ojuawo & Oduntan (2015) concluded that male students outperformed female students on CBT, whereas Jalali, Zeinali, & Nobakht (2014) emphasized that female students outperformed male students in both modes. Furthermore, Wallace and Clariana (2005) found that male students outperformed their female peers on the initial assessment regardless of the test mode, whereas female students using CBT outperformed male students on the final assessment. On the contrary, Alexander, Bartlett, Truell & Ouwenga (2001) noted no gender differences in performanceof both test modes. Jeong (2012) found the male mean CBT scores were significantly different in comparison to PPT scores in only one of four academic areaswhereas, females had statistically significant lower scores on three of the four academic areas for CBT scores, suggesting a gender gap on computer usage. Students in this study had been receiving weekly computer literacy lessons for five years; however, the students were all new to CBTs. Bennett, Braswell, Oraje, Sandene, Kaplan & Yan (2008)found gender did not account for test mode differences on CBT While

Clariana and Wallace (2002) found statistically significant score differences favoring CBT. Additionally, in terms of gender, no differences were found in other studies (Lee,Osborme & Carpenter 2010; Poggio et al., 2005). Analyzing the scores of middle school students from a national mathematics test in England, boys were found to be more likely to fail to submit an answer when testing on either mode (Johnson & Green, 2006). This difference was moderated when testing on the computer. while other studies suggestthat genderis associated with the test mode (Leeson, 2006; Gallagher et al., 2000), with male examinees benefiting from the CBT more than female examinees who showed slightly poorer performance on CBT. Also, Oduntan et al. (2015) and Jalali, Zeinali, & Nobakht (2014)concluded that male students outperformed female students on CBT.Halpern (2000) in a study indicated that males are frequently observed to obtain average higher scores on some tests of spatial ability, mathematical reasoning, and targeting, while females are often found to have average higher score on some tests of memory, verbal ability, and motor coordination within personal space.The issue of gender differences in creative thinking is a complex and controversial one. Although gender differences in creativity have been assessed in several studies, the results have been inconsistent. For instance, researchers such as Jaquish and Ripple [32]; Agarwal and Kumari [33] found no statistically significant gender differences whereas others like Coone [34]; Tegano and Moran [35] among others found gender differences, at times favouring female and sometimes favouring male [36]. A study conducted among students concerning the role of gender in creative thinking and performance revealed that male students scored high than female students. It means the male students were better in creative ideas than the female counterparts. It was concluded that there was a great impact of gender to the five components of creative thinking ability [37]. Similarly, Naderi, Abdullah, Aizan, Sharir, and Kumar [38] in their study concerning creativity and gender academic performance revealed no difference in performance of male and female students.

Many studies researchers like, Chuah, Drasgow, & Roberts, 2006; Gosling, Vazire, Srivastava, & John, 2004 found significant differences between computer-administered testing and traditional paper and pencil testing. These studies and articles attributed achievement differences to several factors. Russell and Haney (1996) found significant differences in the performance of students on the National Assessment of Educational Progress computerized tests when compared to traditional paper and pencil tests. They compared 42 students tested on a computer-administered test with scores of 47 students tested on a traditional paper and pencil test. In addition to answering multiple-choice items, there were open-ended items requiring original responses. For scoring, raters only saw the computer products because all hand-written responses were entered into the computer verbatim after the test concluded. Larger mode effects were found on open-ended writing tasks than on multiple-choice tests. Additionally, analysis showed that students who wrote on the computer tended to organize their work into paragraphs and wrote responses nearly twice as long as the students who hand wrote their responses. Karadeniz (2009) studied the impact of paper based, web based and mobile based assessment on students' achievement. A group of 38 students was experimented for 3 weeks. Significant differences were found between the scores achieved by the students in second week, but not in the first week. The authors perceived that students had positive attitude towards web based, mobile-based assessment due to ease of use, comprehensive, and instant feedback. Moreover, most favored tests were web-based and the least favored were

paper-based. In another experimental research, Bodmann and Robinson (2004) conducted an experimental study to compare speed and performances differences between computer-based (CBTs) and paper-pencil tests (PPTs). Both CBTs and PPTs contained 30 MCQs items with 35 minute of time limit. Approximately half the class (i.e. 28 students) took the first test on the computer and the rest preferred first test on paper. Procedures shifted for the second tests, with the first group receiving PPTs and second group received CBTs after two weeks. It was concluded that undergraduates completed the CBT faster than PBT with no difference in scores. Oduntan, Ojuawo & Oduntan (2015) investigated Comparative Analysis of Student Performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination System showed that students generally are becoming interested in the use of modern method of assessment, which is the computer-based test. During the analysis, it was clear that the performance of the students when they wrote the computer-based test were better than the performance of the same students who wrote the paper-based test.

In fact, many research works have been conducted to evaluate the comparability of computer-based assessment and paper and pencil-based assessment. Some studies revealed that there is a significant difference between the two testing modes on test scores Scheuermann & Björnsson, 2009; Choi, Kim, & Boo, 2003), while other studies reported opposite or inconsistent results (e.g. Al-Amri, 2009; Boo, 1997). However, unlike the abundance of CBT research done with older or special needs students, there is a dearth of available research focusing on the issues of computer-based assessment with typically developing young children (Barnes, 2010).

Purpose of the Study

The main purpose of this study was to compare Early Childhood Care Education Pre-Service Teachers Performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity. Specifically, the study sought to:

i. Compare the mean achievement scores of Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity.
ii. Compare the mean achievement scores of male and female Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of Early Childhood Care Education Pre-Service Teachers in in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity?
2. What are the mean achievement scores of male and female Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity?

Hypotheses

The following research hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of Early Childhood Care Education Pre-Service Teachers in in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity.
2. There is no significant difference in the mean achievement scores of male and female Early Childhood Care Education Pre-Service Teachers in in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity?

Methodology

The research design adopted for the study was survey research design. The research design examines the difference between the performances of Paper-Pencil Tested (PPT) and Computer-Based Test (CBT) of 300 NCE level Early childhood care education Pre-service teachers in Alvan Ikoku Federal College of Education, Owerri. The population for this study comprises 172 Pre-service teachers. A sample of 100 was selected through Simple random sampling technique study involving 24 males and 28 females for PPT (52 participants) while 23 males and 29 females in CBT (52 participant). The instrument used for data collection was a Mathematics Creativity Test (MCT). It was a 50-item multiple choice test format. The items were developed by the researchers with special attention on geometry special area on 2 and 3 dimensional shapes, Construction and bisection of angles and problem solving questions in mathematics that requires critical thinking skills and science process skills to solve. The construction of the instrument was guided by a table of specification to ensure adequate coverage of the content area covered in the study as well as maintain even spread across the different levels of the cognitive domain. An item contains a stem and four different options lettered A, B, C, and D in which only one is the correct answer while the others are termed by evaluating experts as decoys (distracters). The MCT items tested recognition of relationships and sensitivity to problems as aspects of mathematics creativity. The instrument (MCT) were given to two experts in Measurement and Evaluation and one expert in Mathematics Education in Alvan Ikoku Federal College of Education Owerri. Their advice was sort in terms of scope of coverage, content validity, plausibility of distracters and clarity of expression in the instrument. Also, the expert in Mathematics Education were required to solve MCT and choose the correct answers, so as to be sure of the correct answers agreed with the researcher's answers. They made certain observations and their corrections were used to review the MCT.The reliability of MCT was ascertained using kuder-Richardson Coefficient (K-20) and found to be 0.82. It has two versions which were the printed/hardcopy and the softcopy for PPT and CBT respectively. The CBT version was programmed on the Computer laboratory center of Department of Science department science Alvan IKoku Federal College of Education. The PPT and CBT mathematics creativity examination took place the same day and the same time with the help of six research assistance trained for the purpose of the study. Mean and standard deviation were the descriptive statistics used in answering the research questions while t-test statistics was used to test the hypotheses at 0.05 alpha level of significant

Results

Research Question one: What are the mean performance scores of Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity.

Table 1: Mean and Standard Deviation on mean performance scores of Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematics creativity.

Mathematics creativity	Number	Mean Score	SD
Paper Pencil Test (PPT	52	32.5	5.8
Computer Based Test (CBT}	52	38.3	7.3

Results in table 1 shows that mean performance scores of Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test is (32.5, SD 5.8) and Computer Based Test (38.3, SD 7.3) Examination in Mathematical creativity. This implies that CBT perform better than PPT.

Research Question two: What are the mean performance scores of male and female Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical creativity?

Table 2: Mean and Standard Deviation on mean performance scores on gender mathematics creativity

Mathematics creativity	Gender	N	Mean	SD
Paper Pencil Test (PPT	Male	24	16.29	3.4
	Female	28	15.21	2.4
Computer Based Test (CBT}	Male	23	19.18	3.6
	Female	29	19.12	3.7

Result in table 2 shows that the mean performance scores of male and female Early Childhood Care Education Pre-Service Teachers in in Paper Pencil Test (Male 16.29 and Female15.21) and Computer Based Test (male 19.18, Female 19.12) Examination in Mathematical creativity. This implies that male and female CBT perform better than gender PPT.

Hypothesis testing

HO1; There is no significant difference in the mean achievement scores of Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical creativity.

Table 3: T-test analysis on the difference between the performance of Computer-Based Test and the Paper-Pencil in Mathematical creativity

Test mode	N	Mean	SD	DF	t-cal	t-crit	Sig	Decisions
Paper Pencil Test (PPT)	52	32.5	5.8	102	2.67	1.96	0.005	Reject HO
Computer Based Test (CBT}	52	38.3	7.3					

From table 3 above, the t-test statistics of significance was used for analysis at 0.05 level of significance. The result shows that there is significant difference between **the performance of Computer-Based Test and the Paper-Pencil in Mathematical creativity**

HO2; There is no significant difference in the mean achievement scores of male and female Early Childhood Care Education Pre-Service Teachers in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination in Mathematical Creativity.

Table 4 t-test on gender difference between the performance of Computer-Based Test and Paper-Pencil in Mathematical creativity

Mathematical creativity	Gender	N	Mean	SD	t-Cal	t-crit	Sig	Decisions
Paper Pencil Test (PPT)	**Male**	**24**	**16.29**	**3.4**	**2.02**	**1.96**	**0.05**	**Reject Ho**
	Female	**28**	**15.21**	**2.4**				
Computer Based Test (CBT}	**Male**	**23**	**19.18**	**3.6**	**0.78**			**Accept Ho**
	Female	**29**	**19.12**	**3.7**				

Results in table 4 shows that the mean scores of performance in gender PPT (male 16.29, female 15.21) with a standard deviation of 3.4 and 2.4 while the gender CBT (Male 19.18 and female 19.12) The result of the t-test shows the calculated t-value of 2.02 for PPT and 0.78 for CBT is significant at ($P<0.05$) the null hypothesis is rejected for PPT while the null hypothesis is accepted for CBT the researchers concludes that there is significant difference in the performance of PPT while there is no significant difference in CBT scores in mathematical creativity.

Discussion

The Result of the study indicated that Early Childhood Care Education Pre-Service Teachers in CBT perform better than PPT while the hypothesis indicated that there is significant difference between Paper-Pencil Test and Computer-Based Test examination in mathematics creativity. This results are in accord with the finding of Scheuermann & Björnsson, 2009; Choi, Kim, & Boo(2003) conducted a study to evaluate the comparability of computer-based assessment and paper and pencil-based assessment. The studies revealed that there is a significant difference between the two testing modes on test scores. Also, Oduntan, Ojuawo & Oduntan (2015) investigated A Comparative Analysis of Student Performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination System showed that students generally are becoming interested in the use of modern method of assessment, which is the computer-based test. During the analysis, it was clear that the performance of the students when they wrote the computer-based test were better than the performance of the same students who wrote the paper-based test.

Also, the study indicated that Early Childhood Care Education Pre-Service Teachersmale and female CBT perform better than the gender PPT while the hypothesis indicated that there issignificant difference between Paper-Pencil Test and Computer-Based Test examination in mathematical creativity. This result is in accord with findings of Chuah, Drasgow, & Roberts (2006); Gosling, Vazire, Srivastava, & John (2004) found significant differences between computer-administered testing and traditional paper and pencil testing.

Conclusion

The study concludes that Early Childhood Care Education Pre-Service Teachers perform better than in CBT than PPT examination in Mathematical creativity irrespective of gender.

Recommendations

The following recommendations were made:

1. Government should provide an enabling environment for Computerized testing in government schools.
2. Schools should intensify their drive towards e-learning and assess students electronically.

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