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## EFFECTS OF MATHEMATICS INNOVATION AND TECHNOLOGY ON STUDENTS PERFORMANCE IN OPEN AND DISTANCE LEARNING

**Abstract:** This study investigated the effect of mathematics innovation and technology on students' academic performance in open and distance learning. Quasi – experimental research design was adopted for the study. The population for the study consisted of all the 200 level primary education students at the National Open University of Nigeria (Ekiti and Lagos State Chapter). The sample of this study was made of 60 students randomly selected using stratified sampling technique. Hypotheses were postulated to find out whether, (i) mathematics innovation and technology influences academic performance of open and distance learning students (ii) location and gender disparity influences academics performance of students in mathematics. The study became necessary following the emerging trend of National University Commission (NUC) in sustaining the development of National Open University of Nigeria (NOUN by) ensuring human capacity building at workplace. The study revealed that mathematics innovation, location, gender and technology influences academic performance of students in mathematics. Based on the findings it is recommended that mathematics innovation and technology should be embraced in Open and Distance Learning so as to enhance better performance of students in mathematics.

**Keywords:** Innovation, Technology; Performance; Open and Distance Learning.

### Introduction

Emergence of Open and Distance Learning (ODL) in Nigeria seems to have strengthened the awareness, appreciation and application of Information and Communication Technology (ICT) among its users. Although, the place of mathematics and technology cannot be underestimated in the current advancement in ICT. However, technology had replaced many of human activities through innovation in curriculum particularly in ICT driven, which has been integrated into mathematics learning. Oyelekan & Aderogba (2011) remarked that the effective use of ICT in education is an important factor in determining which country will succeed in the future.

Open and distance learning is a learning approach in which teacher and learners are separated in time or place and uses a variety of media, including print and electronic, to ensure a two-way communication that allows tutors and learners to interact. It is expected of any admitted students into ODL to be well groomed in computer hardware (projection technology, calculator, digital recording, data-logging) software applications (generic software multimedia

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resources) and information systems (internet, intranet) without which ODL would not be able to achieve its objective.

### Literature Review

In Nigeria and all over the world, educational experience and training in diverse knowledge and skills prepare one to face challenges in life. Individuals then become empowered to modify their environment to meet their needs and desires which is in line with policy on education (Adepoju & Amoo, 2005). In order to achieve educational goals and Mathematics teaching effectiveness, improving the quality of education is a critical issue, particularly at a time of our technology expansion and innovation. One of the ways to achieving quality in our education is not to undermine the impact of Information and Communication Technology (ICT) in our school system as stated in the policy (FRN, 2004).

With the emergence of technology in the classroom, Amoo (2010) opines that if ICT facilities integrated in junior and senior secondary schools are of good quality and the students have access and utilize the facilities, there is hope that the attitudes of students would change; there might be improved motivation towards learning school subjects (mathematics inclusive). This is equally a function of how mathematics teachers effectively employ the ICT facilities in helping students in their classroom.

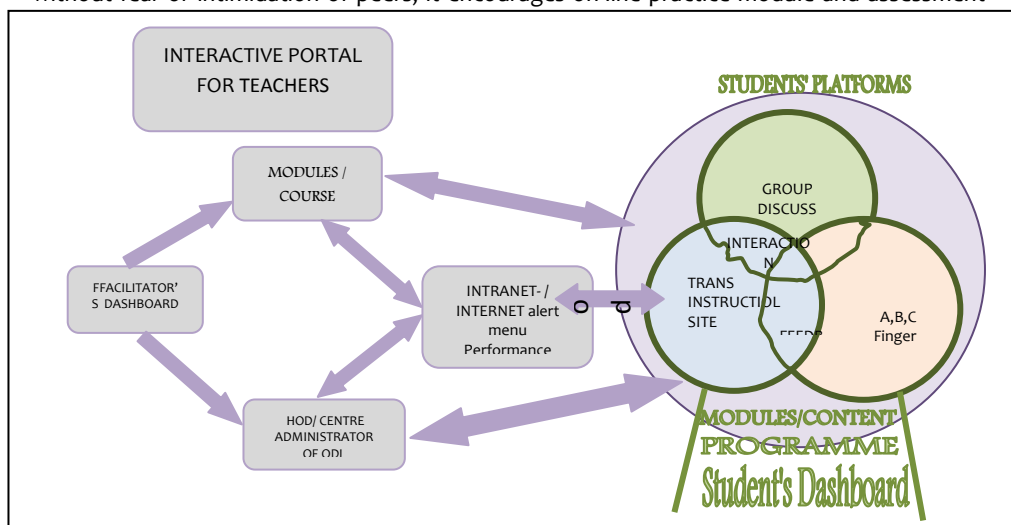
According to Oginni (2013) mathematics is embraced worldwide as an asset to all knowledge, since it influences all facets of human endeavour. It is therefore needful for the teaching and learning of mathematics in ODL to be more involving through interaction between facilitators and students learning it in the area of data logging, intranet and internet among others. Mathematics innovation has the potential to increase access to and improve the relevance and quality of education in developing countries. Innovation and technology can be used to provide educational opportunities to people who have previously had no access to education, such as scattered and rural populations, groups traditionally excluded from education because of cultural or social reasons, persons with disabilities and the elderly. This is possible because such technologies allow asynchronous learning, which is characterized by a time lag between the delivery of instruction and its reception by learners. ICT-based educational delivery exposed as unnecessary the need for the instructor and all learners to be in one physical location.

The uses of technology have kindled great interest in mathematics education. Currently, considerable resources are being expended to connect students to the global network through the implementation of Advanced Intranet-Internet Pedagogical Package (AIIPP). Jacobson et al (2000) advocated that advance design is an innovation in science and mathematics education that would enable students to appreciate electronic teaching. Yusuf (2005) stated that technology and mathematics innovation provide opportunity for stakeholders to communicate with one another through email, mailing list, chat rooms and providing quickens and easier access to more inclusive and current information. ODL in Nigeria cannot afford to be in isolation, since technology has become an integral part of our daily lives. The current global realities in the 21<sup>st</sup> century has tremendously accelerated the forces of globalization.(Christian, 2009)

These global realities have no doubt divided the world into advanced and developing nations. The advanced nations are the ones with highly educated citizens, which are reflected in their

high technological innovation and mathematics understanding. The developing nations are characterized by low educational attainment, poor mathematics indices and low technology innovation. (Dantani & Kubo, 2011) Some types of ICTs, such as teleconferencing technologies, make it possible for multiple, geographically dispersed learners to receive instruction simultaneously. The Internet and the World Wide Web also provide access to learning in almost every subject and in a variety of media anywhere at any time of the day and to an unlimited number of people. One of the most commonly cited reasons for using ICTs in education have been to better prepare students for a workplace where ICTs are becoming more and more ubiquitous. In addition, technology can improve the quality of education by increasing learner engagement and motivation, by facilitating the acquisition of basic skills and by enhancing teacher training.

Advanced Intranet-Internet Pedagogical Package is an innovation in mathematics education that could enable the learners in ODL identify with the teaching / learning technique that meet the standard of advanced nations of the world. AIIPP is regarded as technology. It is essential in teaching and learning mathematics particularly in an environment where teacher and learner cannot afford face to face interaction. It influences Mathematics appreciation in an environment characterized by online interaction among its users and enhances students' participation. AIIPP expresses a value judgment regarding the role of technology in mathematics teaching and learning. AIIPP is an educational portal for teachers and students robust interaction in mathematics. It enables the learners to ask question to any length without fear or intimidation of peers, it encourages on-line practice module and assessment



**Advanced Intranet-Internet Pedagogical Package**

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Advanced Intranet-Internet Pedagogical Package (AIIPP) is made up of an interactive platform for both registered facilitators and students of ODL. Facilitators on AIIPP are permitted to access information regarding their students in the area of assigning courses, granting permission to do and undo courses, transmitting knowledge, referral and consultation, giving assignment, responding to individual and corporate agitations, grading and assessing of examination as well as Tutor Made Assignment (TMA) scores on their dashboard,through

AIIPP administrator and intranet/internet menu permission.

The motive for AIIPP platform is to encourage teaching learning in cyclic model, whereby (A, B, C) students or group of students can access instruction provided by the facilitator and give feedback intermittently anytime the alert icon is display on their dashboard from either peers or instructors.

By opening opportunities for students to initiate interactions and by managing a lesson's knotty issue within classmate gave rise to constructive criticism among peers. This in turn may be guided latter by their facilitator as a result intranet/internet package for better learning strategy in mathematics. Facilitators always notice and give attention to correct and incorrect responses, observing students' mistakes during interaction, which may propel the facilitator to search for new explanations or clarification in order to streamline students understanding for the construction of innovation in mathematics. According to Atkinson and Claxton (2000) many of the teacher's action when teaching are intuitive and unplanned. The transformation of ideas through AIIPP encourages mathematical intuition, which eventually reinforces pedagogical intuition.

Innovation of AIIPP enables the facilitators to work, plan, perform and analyze each modules or lessons based on students cross breeding of ideas, thereby understanding students' possible difficulties, answers and questions. AIIPP has a long term memory that lasted for about four consecutive semesters, therefore students and facilitator can refer to any of the already taught module/unit for clarification.

Males are more likely to develop interest in the mathematics and technology than females; in contrast, females are more likely to develop an interest in social sciences, languages and reading than males (Eccles et al., 1998). These different preferences in males and females become more intense during the secondary school years, the time in life when adolescents must choose school subjects and academic paths. Several studies have shown that such choices are influenced by such psychological factors as their hierarchy of interests, ability self-concepts and domain specific self-efficacy beliefs, and the perception of costs and benefits of getting involved in different activities (Bandura, Barbaranelli, Caprana, & Pastorelli, 2001; Deci & Ryan, 1985; Eccles, 1994; Eccles & Wigfield, 2002).

Mathematical abilities are considered a prerequisite for those students wanting to enroll in technological studies and those who want to gain admission to ODL and the related colleges and university for majors and professional occupations (Meece, Eccles-Parsons, Kaczala, Goff, & Futterman, 1982). For this reason, those students excelling in mathematics-related subjects in secondary are the ideal candidates for advanced technology and science related degrees. It has long been argued that males are more likely to have mathematical talent than females while females are more likely than males to have verbal talent, leading males to do better in mathematics, to develop high mathematics ability self-concepts, and to be more likely to enter mathematics related technical fields (Eccles et al., 1998; Guimond & Roussel, 2001; Skaalvik & Skaalvik, 2004). However, the validity of this explanation has been called into question by the metaanalytical research of Hyde, Fennema, and Lamon (1990).

Despite the fact that the gender differences when present favour males on competitive tests of Mathematics ability, females in general get better grades than males in mathematics courses and the proportion of females majoring in mathematics per se (rather than the physical sciences, engineering and technology) matches that of males in some countries, such

as the USA (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). For example, in Spain women made up 50.09% of the undergraduates seeking a university degree in mathematics in 2006–2007 (Instituto de la Mujer, 2010). This pattern of equal participation of women in the university degree of mathematics has remained constant for more than 10 years ago. Thus, it is not clear that mathematics per se is stereotyped as male. More recent studies suggest that most children, particularly girls, indicate that neither boys nor girls are more likely to excel in mathematics (Ruble, Martin, & Berenbaum, 2006). So perhaps it is not the stereotype of mathematics per se that is negatively influencing girls' performance on tests of mathematical skills, but rather stereotypes associated with the physical sciences, technology, and engineering.

This paper examines how mathematics innovation and technology (AIIPP) influences academic performance among students in ODL. There are many ways of viewing the mathematics curriculum, depending on the levels and the category of discipline offer the subject.

### Research Hypotheses

- 1; There is no significant difference in the pre-test score of students taught MAT with AIIPP and those in conventional group
- 2; There is no significant difference in the post-test score of students taught MAT with AIIPP and those in conventional group
- 3; There is no significant difference in the retention score of students taught MAT with AIIPP and the experimental group
- 4; There is no significant difference between location and the academic performance of students taught MAT with AIIPP
- 5; There is no significant difference between gender and the academic performance of students taught MAT with AIIPP

### Methodology

The purpose of this research is to investigate the effectiveness of mathematics innovation and technology on the academic performance of ODL students in mathematics and to ascertain whether there is variability in the performance of the students taught with the mathematics innovation and technology and the control group.

This study adopts quasi- experimental pre test post test two group design. The experimental group (X) was exposed to mathematics innovation and technology while the control group was exposed to usual science conventional approach. The design of the study was as follows;

Experimental group X:  $O_1$  X  $O_2$

Conventional group, Y:  $O_3$  Y  $O_4$

Where

$O_1, O_3$ ; pre test (performance to the two groups)

$O_2, O_4$  post test(performance to the two groups)

X treatment is given through AIIPP.

Y conventional method of teaching

The population of this study consisted of all the 200 level Nursery Primary Education (NPE) undergraduate at the National Open University of Nigeria (Ekiti and Lagos State Chapter). The

sample was made up of 60 students which are selected using stratified random and multi stage sampling techniques.

### Instrumentation

The instrument used for the study was Mathematics Achievement Test (MAT) displayed through AIIPP designed by the researcher from one of the mathematics courses, titled Measurements and Shapes (PED237). The face and content validity of the instrument was ascertained by given the instrument to the experts in mathematics education and curriculum experts. The results of their inter-rating yielded the coefficient of 0.74, which is high enough to confirm the validity of the instrument. Test – re- test method was used to obtain the reliability of the instruments and the reliability co-efficient was found to be 0.91 which was high enough to make the instrument reliable. The researcher, being a facilitator in ODL, administered pre test for the concern groups. Hence, AIIPP treatment was administered on the experimental group, having made his dashboard accessible from Wednesday 12a:m till Saturday12a:m on weekly basis for the period of six weeks for rigorous and comprehensive pedagogy and other activities with the learners.

### Result

*Hypothesis 1;* There is no significant difference in the pre-test score of students taught MAT with AIIPP and those in conventional group

Table 1; t-test Summary of Pre-test score of the experimental and Conventional Group

|   | N  | $\bar{X}$ |      | SD | df   | t <sub>cal</sub> | t <sub>tab</sub> | Res |
|---|----|-----------|------|----|------|------------------|------------------|-----|
| A | 30 | 19.3      | 3.46 | 58 | 0.79 | 2.021            | NS               |     |
| B | 30 | 16.9      | 2.38 |    |      |                  |                  |     |

P < 0.05

Table 1 showed the pretest mean score of the experimental and control group  $\bar{X}$  (19.3, 16.9), SD (3.46, 2.38), t<sub>cal</sub> (0.79) < t<sub>tab</sub> (2.021) at alpha level of 0.05. Therefore the null hypothesis is not rejected; hence, there is no significant difference in the pretest score of students in experimental and control group. By implication, there was homogeneity in the performance of the two groups' prior treatment.

*Hypothesis 2;* There is no significant difference in the post-test score of students taught MAT with AIIPP and those in conventional group

Table 2; t-test Summary of Post-test score of the experimental and conventional Group

|   | N  | $\bar{X}$ |      | SD | df    | t <sub>cal</sub> | t <sub>tab</sub> | Res |
|---|----|-----------|------|----|-------|------------------|------------------|-----|
| C | 30 | 52.53     | 2.85 | 58 | 3.205 | 2.021            | Sig              |     |
| D | 30 | 34.23     | 4.95 |    |       |                  |                  |     |

P < 0.05

Table 2 showed the post test mean score of the experimental and conventional group  $\bar{X}$  (52.53, 34.23), SD (2.85, 4.95), t<sub>cal</sub> (3.205) > t<sub>tab</sub> (2.021) at alpha level of 0.05. Therefore the null hypothesis is rejected; hence, there is significant difference in the post test score of

students in experimental and control group. By implication, there was significant difference in the performance of the two groups after treatment in favour of the experimental group

*Hypothesis 3*; There is no significant difference in the retention score of students taught MAT with AIIPP and the conventional group

Table 3; t-test Summary of retention score and the post test score in the experimental group

|   | N  | $\bar{X}$ | SD    | df | $t_{cal}$ | $t_{tab}$ | Res |
|---|----|-----------|-------|----|-----------|-----------|-----|
| E | 30 | 64.9      | 10.64 |    |           |           |     |
|   |    |           |       | 58 | 3.638     | 2.02      | Sig |
| F | 30 | 34.23     | 4.95  |    |           |           |     |

P < 0.05

Table 3 showed the retention mean score of the experimental  $\bar{X}$  (34.23, 64.9), SD (4.95, 10.64),  $t_{cal}$  (3.638) >  $t_{tab}$  (2.021) at alpha level of 0.05. Therefore the null hypothesis is rejected; hence, there is significant difference in the retention score of students in experimental group. By implication, there was significant difference in the performance of the students after post test in favour of the experimental group. This shows that the students exposed to treatment retained better than those of other group.

*Hypothesis 4* There is no significant difference between location and the academic performance of students taught MAT with AIIPP

Table 4; t-test Summary of the students from different location exposed to AIIPP

|   | N  | $\bar{X}$ | SD    | df | $t_{cal}$ | $t_{tab}$ | Res |
|---|----|-----------|-------|----|-----------|-----------|-----|
| D | 15 | 51.60     | 3.141 |    |           |           |     |
|   |    |           |       | 28 | 0.6113    | 1.753     | N S |
| E | 15 | 53.47     | 2.757 |    |           |           |     |

P < 0.05

Table 4 showed the mean score of the experimental group from different location  $\bar{X}$  (51.60, 53.47), SD (3.141, 2.757),  $t_{cal}$  (0.6113) <  $t_{tab}$  (1.753) at alpha level of 0.05. Therefore the null hypothesis is not rejected; hence, there is no significant difference in the students' performance from different location. By implication, location has nothing to do with the academic performance of ODL students in mathematics if essential technology is in place for teaching and learning.

*Hypothesis 5* There is no significant difference between gender and the academic performance of students taught MAT with AIIPP

Table 5; t-test Summary of the gender exposed to AIIPP

|   | N  | $\bar{X}$ | SD    | df | $t_{cal}$ | $t_{tab}$ | Res |
|---|----|-----------|-------|----|-----------|-----------|-----|
| D | 15 | 72.53     | 9.191 |    |           |           |     |
|   |    |           |       | 28 | 2.00      | 1.753     | Sig |
| E | 15 | 57.33     | 5.158 |    |           |           |     |

P < 0.05

Table 5 showed the mean score of the gender exposed to mathematics innovation  $\bar{X}$  (72.53, 57.33), SD (9.191, 5.158),  $t_{cal}$  (2.007) >  $t_{tab}$  (1.753) at alpha level of 0.05. Therefore the null hypothesis is rejected. Therefore, there is significant difference in the gender performance in

ODL mathematics. By implication, male students perform better than their female counterparts in ODL mathematics lesson.

### Discussion

The result of the findings reveals that there is significant difference in the performance of the ODL students exposed to Advanced Intranet-Internet Pedagogical Package (AIIPP) and the conventional group, in favour of the students taught with AIIPP. The study is in line with the findings of Jacobson et. al (2000) that the use of advance design in mathematics teaching enhances academic performance of students in mathematics and sciences. The finding is in conformity with the experiment carried out by Owolabi and Oginni (2014) that the animated cartoons that were used to synchronize lesson presentation to the experimental group in science produced greater academic performance in the post-test. However, Amoo (2010) confirm the earlier findings that the professionals that are ICT compliance and mathematically certified are to be allowed to teach mathematics at any level and those who are yet to have pedagogical knowledge of the subject matter be encouraged to do so.

The result of the findings also shows that the use of AIIPP improves academic ability and aids retention level of the students in mathematics learning, Another finding of Vogel, Gebrin and Nicholas (2010) was parallel to the initial study on knowledge acquisition and application as well as short term retention is better supported by animated imagery compared to static imagery when teaching human system interactions.

The study reveal that environment of the learners in ODL is not a determining factor for better performance of students in mathematics. This is in line with Amoo (2010) who found that the ways to achieving quality in mathematics education is not to undermine the impact of Information and Communication Technology (ICT) in our school system. This finding contradicted the views of Popoola and Oginni (2012) that the sophistication and impressive performance displayed by the undergraduates in private Universities regarding their assessment of online interaction in mathematics over their public universities undergraduates' counterparts is significant. The study opposes the view of Amoo (2010) who found that school environments and psychological traits promotes learning mathematics among gender in secondary schools.

The findings also reveal that male students perform better than their female counterparts in ODL Which corroborated the findings of Bandura, Barbaranelli, Caprana, & Pastorelli, (2001); Deci & Ryan, (1985); Eccles, (1994); Eccles & Wigfield, (2002) that male choices of mathematics are influenced by their psychological factors, hierarchy of interests, ability self-concepts and domain specific self-efficacy beliefs, and the perception of costs and benefits of getting involved in different activities. In contrary, Divjak, Blazenka; Ostroski, Mirela; Hains, Violeta Vidacek (2010) remarked that although only minor gender differences in different skills have been detected, the pass rate for female students is constantly higher than that for male students. Therefore, the reasons for the better performance of female students have been investigated taking into account both the motivation for study and learning styles. Earlier study of Oginni (2013) affirmed that there is no gender discrepancy in the scores of male and female pupils while exposing them to ICT teaching. The result is contrary to the findings of Kolawole and Oginni (2009) that male students performed better than their female counterparts in mathematics laboratory lessons.



## Implications and Conclusion

This study can assist the students, teachers, curriculum planners and mathematics educators and evaluators in focusing on AIIPP as a new version to impart knowledge of mathematics in such a way that will improve the present standard at any level of our educational system particularly in ODL. It can assist in planning online teaching and learning effectiveness. It can assist pre-professional mathematics teachers to explore the advantages of internet intranet learning to participate in mathematics, as well as designing various strategies that promote effectiveness. It hoped that the readers and stakeholders in education and those who believe in mathematics innovation and technology, gender, school environmental can promote teaching effectiveness and promote mathematics culture in dealing with students.

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### **Biographical note**

**Dr Oginni 'Niyi Israel** is an erudite scholar of tested academic integrity. He obtained Ph.D degree in Mathematics Education. He is a science educator and curriculum expert per excellence. He has contributed immensely to knowledge in the local, national and international journal in his chosen field of endeavour. He is a lecturer of Mathematics and Education in the Department of Science Education of the Faculty of Education, Ekiti State University, Ado-Ekiti, Nigeria. Dr Oginni has been appointed at one time or the other as supervisor and examiner to over 100 undergraduates and postgraduates' students' dissertations and theses. His passion to enhance mathematics teachers' competence and their interaction with students on the latest approach to impact knowledge enables him to investigate into the effects of mathematics innovation and technology on students' performance in open and distance learning. The world is becoming a global village, it is expected that the distance and time should no longer be an hindrance for effective teaching and learning interaction between the teachers and their students without compromising effective and efficient delivery of knowledge. The model postulated in this study would be beneficial to researchers throughout the world.