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EFFECTS OF USING IPAD ON ALGEBRA TEACHING FOR NURTURING MATHEMAT ICS STUDENTS' CRITICAL THINKING

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Abstract
Ipad is a combination of computers and tablets. It uses cover all areas of educational s ectors both in office and classroom instructions. As a means of communication techno logy, ipads facilitated through browsing the internet, receiving and sending emails as we ll as effective classroom mathematics instructions. The aim of this study is to investiga te comparison of students' critical thinking skills on mathematics algebraic topic learnin g with ipads and the conventional method. Pretest-posttest non-randomised control gro up quasi-experimental research design was adopted. Four intact classes of SS3 were ra ndomly chosen for the study and assigned to treatment and control groups. The experi mental groups were taught mathematics algebraic equations using ipads; while, control group conventional method. One research question and one hypothesis were answered and tested. ANCOVA test was used to determine whether the group of mathematics stu dents with ipads had gained higher critical thinking skills to solve problems compared t o the group without ipads. The instrument used for collecting data for critical thinking w as Mathematics Critical Thinking Assessment Test (MCTAT) with 27items questionnair e for 249 SS3 mathematics students. Findings revealed that students taught algebra wit h ipads device scored higher in critical thinking test than their control group counterpart s. Also, there is significant difference between the mean critical thinking scores of SS3 mathematics students taught algebra using ipads than those taught with conventional method. Moreso, statistically significant difference exists between mean critical thinkin g scores of males and females SS 3 mathematics students taught using ipads. Finally, t here is significant interaction effect of gender with ipads usage on mathematics studen ts' critical thinking skills in algebra measured by their POSTMCTAT.

Keywords: *iPADs, Nurturing, Critical thinking toward mathematics*

Introduction

Digital technologies are essential tools coupled with equitable quality education f or all toward achieving the United Nations' Sustainable Development agenda 2030. To o

btain this, the entire educational system needs to shift significantly not as knowledge pr ovider; but, co-creator of information, mentor, and an assessor through digital technologi es (Abid, Mohd, Mohd and Rajiv, 2022). Instructions become easier for mathematics stu dents moving from using pen and paper in learning. Mathematics students' ways are sh arpened to understand the world; interact with their environment to assimilate informatio n and learn faster. No wonder, Adeline and Hee (2024) opined that digital devices have p ervaded our society at a supercharged speed. This rapid digital technology in education had proven to have positive effects on students' development in mathematics. The studi ed of Chen, Teo, and Nguyen (2019) shown that the use of devices in teaching developed students' motor skills; making them learn at their own pace as well. One of the things tha t can bring significant changes that will in turn change students' interaction in mathemat ics is iPADs. When ipads are given appropriate attention in classrooms mathematics in o ur secondary schools, learning innovative patterns can be improvised (Mazlan and Siti, 2 020). Ipad is easy-to-use being wireless digital tool which help mathematics students to have unlimited access to learn mathematics materials. According to Zakrzewski (2016) i pads should be given adequate attention than the conventional method; because it is us er-friendly, light weight and wireless medium in classrooms digital technology implement ation. The conventional classroom instructions fall short in providing satisfactory and m ore engagement learning environment to faster adequate students' evaluations (Abid, eta l, 2022). When students are engaged using ipads in learning experience, it allow them to remain more interested in the topic without being distracted.

Students learning with ipads make them gain better understanding of mathematical concept (Mazlan and Siti, 2020). The usefulness of ipads in passing instructions to stud ents cannot be overemphasised. Hence, Hui (2016) and Rosninawati, Suria-Hani, Sofia-H ayati, Rosidayu and Fauziah (2019) findings on ipads usage in schools shown positive e ffects in giving encouragements to mathematics students as well as positive experience s for their teachers. Hilton (2018) studied had confirmed that the use of ipads can provid e positive influence on mathematics students' engagement and change their attitudes to wards mathematics instructions. The studied of Ingram, Williamson-Leadley and Pratt (2

016) revealed that when students are engaged using ipads they are motivated and helpi ng in quick learning whereby increasing their creativity, independence and productivity. M oreso, Rosninawati and Mazny (2020) claimed that ipad is one of the flexible tools that s park students' engagement with new ways to learn inclusiveness with software that help the mathematics teachers to come out with innovative tools in teaching. According to Hu i (2016) ipad can train mathematics teachers to be facilitators of knowledge who facilita te the instructions processes. Using ipad according to him, mathematics teachers becom e more creative in building learning content to students. For you to be creative according to Natalle (2024) you need a lot of brilliant ideas, a good sense of design, and the ability to think critically. When mathematics students' think critically in ipads classes, they are more positive in managing their own learning time and their involvement become easier i n mathematics teaching. Despite all these, ipads had been proved to be useful by keepin g mathematics students motivated and excited about their learning; making them to acc ess new learning materials via internet resources. Students' shifts learning from teacher-centred to child-centred allowing them work at their own pace without waiting for the ma thematics teachers instructions in mathematics classroom. Thus, the mathematics teac hers can easily identify and differentiate every student comprehensive level skill being di fficult to verify. Bogami and Elyas (2020) affirmed that ipads usage in secondary school s motivate students to learn, stay on task, collaborate with peer group to improve their en joyment making them learn more independently becoming curious. When students are c urious they are nurture in instructions being learn in classroom. However, Zakrzewski (20 16) suggested that ipads is expensive; but, can provide access to online mathematics te xtbooks when updated annually reducing costs. Yale Tribune (2018) highlightened reaso ns against ipads usage by school students to include:

1. Ipads have taking students away from the important lessons they ought to be learning such as social skills development, teamwork, creative development a nd physical skills;
2. Ipads add to financial problems of the educational system;
3. Ipads are mere entertainment than education.

Thinking is the process that created unconsciously in a person (Rahmy, Wahyudin and Jarnawi, 2018). It implies that thinking process is a way to solve problems faced by mathematics students. When mathematics students thinking processes are done well, le ad to good results in learning. Hence, learning when it is only based on memorising som ething, other materials taught by the teacher will be forgotten (Rahmy et-al, 2018). Educa tional purpose is not only to memorise something; but, to provide full understanding to meaningful learning outcomes. So thinking must not only be seen from mental process of observing, analysing and interpreting; but, critical to make value judgement on what y ou read, hear, say and write. Becoming a better critical thinker as mathematics student, y ou need to learn how to: clarify your thinking purpose and context; question the informati on sources; identify and evaluate others arguments; to enable you create your own argu ments (Monash University, 2024). Critical thinking comes from the Greek word Kritikos (a ble to judge or discern). University of Louisville (2024) defined critical thinking as intellec tual disciplined process of activity that uses skillful conceptualised applications, analysi ng, synthesising, in order to evaluate information gathered from observation, reflection e xperience, reasoning, and communication, serving as a guide to belief and action. It there fore means that to think critically, you must be aware of your own biases and assumptio ns when gathering information involving applications of consistent standards to evaluat e it. Ryan (2023) gave the best definition of critical thinking as the ability to effectively a nalyse information to form judgement. Another word for critical thinking is problem-solvi ng (Mbhagin, 2020). Critical thinking according to Mbhagin (2020) involved the methodo logy of analysing that available facts, evidences, observations, and arguments to form a useful judgement; while, problem-solving is the act of defining that problem, determining the problem cause, identifying, prioritising, to select alternatives for the solution, then im plementation. So education and training of students must go beyond conventional Scien ce Technology Engineering Mathematics (STEM) fields, must encompassed digital litera cy, critical thinking and problem-solving skills (Bryant, 2024). Thus, the mathematics curr iculum in our secondary school needs to emphasis these fundamental skills of literacy, n umeracy and critical thinking to enable students gain solid and effective academic foun

dation to solve problem with easy using ipads devices. Hence, schools must play an imp ortant role in developing critical thinking skills in mathematics students by going deeper than conventional multiple choice that is the true/false testing questions. Good critical t hinking assessment skills must enable students to look at data, develop good solutions t o problems, and express their thinking effectively. The observable character found in a m athematics student with critical thinking skills enlightened by Rahmy, Wahyudin and Jar nawi (2018) and Matthews (2024) are: ability to do the job with sincerity; being diligent i n finding the needed information to solve the problem; being able to choose a decision c arefully; having strong perseverance despite facing difficult problem in the processes of solving the problem; and being able to solve problems following appropriate processes t o decisions. According to Matthews (2024) critical thinking is the ability to clearly and lo gically consider information presented to you as mathematics student in class and hom e. So the mathematics students need to understand the processes of identifying the chal lenges of using effective methodologies (critical thinking, analysis and creative reasonin g) to arrive at solutions. PACIER (Problem-Solving, Analysis, Critical thinking, Interpretatio n, Evaluation, and Reasoning) framework developed by Macat International to assess m athematics classrooms critical thinking skills should be adopted in order to arrive at solu tions to problems. Matthews (2024) viewed Problem-solving as systematic method to ap proach a situation whereby evaluating options; implementing them to get the needed res ult; while, Analysis is the breaking down of the complex information, concepts into small er parts for the students to understand their underlying structures, relationships and impl ications. He noted that Critical thinking is more focused on a logical and rational process of evaluating that which had already exists. Interpretation is the process of looking at ho w the mathematics students interpret information and implement them into their thinkin g. Evaluation being the process of taking all information levels from basic to advance, ar riving at decision. Reasoning is the cognitive process of drawing logical conclusions, ma king inferences to form judgements when evidences and related ideas are used. Azizbek (2024) stated that critical thinking assessment tools are instruments to measure level of critical thinking skills and abilities of students. These instruments are important in the fo

llowing ways: help the students to understand their thinking process, identify their streng ths and weaknesses; helping students to monitor learning progress and to improve overti me; helping them demonstrate their critical thinking skills with others (peers, educators et c).

Nurture is a tried and tested way of relating to students helping them develop vital so cial skills, confidence and self-esteem, becoming ready to learn (Nurtureuk, 2023). Nurtur ing offers ranges of opportunities in education for students to engage with their social a nd emotional skills to do well at school and peers to develop their resilience and self-con fidence. Students are pride in achieving these social and emotional needs that can hamp er effective learning. There are six principles for students nurture in classroom by Eva Ha lmes and Eve Boyd cited in Nurtureuk (2023) as:

1. Transitions: the importance of transitions in students' lives
2. Learning: students learning is understood developmentally;
3. Behaviour: all behavioural communications can do well using good modelling;
4. Language: language is a vital means of communication making interaction wi th students effective;
5. Wellbeing: The importance of nurture for the development of monitoring the s ocial and emotional wellbeing of the whole class;
6. Safety: the classroom offers a safe base. This encourages students to work in pairs and groups.

Nurture allows students to connect with one another to build sense of self-worth (Nur tureuk, 2022). This helps them to learn, play and communicate effectively making them t o thrive. According to Fisher, Lucas and Galstyan (2013), little researches have been don e involving direct observation of the ipads usage in mathematics classroom to nurture cr itical thinking. Most of them focused on analysing students' and teachers' perceptions o n ipads benefits rather than its effects on critical thinking skills. In order to incorporate ip ads into the school mathematics classroom instructions, researches need to be conduct ed to determine the effect, if any on mathematics students' learning to nurture students' critical thinking. Studied had shown that ipads has potential in contributing to mathemat

ics instructions in schools; however, its application is still not well implemented (Joubert, 2013 and Mazlan and Siti, 2020). How effective is ipad device on mathematics students' teaching to nurture their critical thinking and the conventional method (without ipads) in Delta State secondary schools? Is there difference between mathematics students' nurtured their critical thinking in Delta State secondary schools?

Statement of the problem

The conventional method of teaching mathematics is the teacher-oriented one with the whole lessons instruction focused more on lecture; mastery of facts and skills. This had made the mathematics teacher sole problem solver for the class; and students' differences are only addressed when there is problem (Sharon, 2017). A single assessment technique is adopted at the end of mathematics instructions (Ornstein, Lasley, and Mindes in Sharon, 2019). In conventional classroom, instructions fall short of providing an immediate comprehensive learning environment, fasting evaluations, and engagement is more (Abid, etal, 2022). No wonder, Fosnot in Sharon (2017), opined that students acquired knowledge by physically constructing it through active learning participation. Ipads, see to provide this quick and easy technique for mathematics teachers to determine students' learning content. The uses of Ipads devices remove constraints of time through provisions of opportunities for students to communicate effectively; collaborate in and out of mathematics classroom. Mathematics students' knowledge created from their experiences through proper interactions with ipads devices. When mathematics students are engaged in using ipads in their learning experiences, it makes them to remain more interested in any mathematics topic without being distracted. Mathematics teachers are not only facilitators of instructions; but, nurturers of students' to build their critical thinking. This is one of the reasons why the researchers are conducting this study in order to verify how effective is ipad device in mathematics teaching among secondary school students in nurturing their critical thinking? Despite ipad negative effect, the advantages of using it to strengthen mathematics instructions in schools are still more positive.

Research Question

The following research question was posed to guide this study:

1. What is the mean critical thinking scores of SS3 mathematics students' taught algebra using ipads compared to their learning with conventional method?

Hypothesis

The following hypothesis was formulated and tested at an alpha level of 0.05:

1. Significant difference does not exist between critical thinking mean scores of SS3 students taught algebra using ipad (experimental group) compared to tho se taught with conventional method (control group).

Methodology

The study adopted pretest-posttest non-randomised control group quasi-experime ntal research design. The reason for this design according to Mazlan and Siti (2020), it p rovides better understanding towards research problems as well as substantial amount o f control factors of the research. A total of four (4) intact classes were chosen for the stu dy randomly assigned to treatment and control groups. Participants in the experimental group were taught algebra using ipad device; while, those in the control groups were taug ht with conventional method. The population was 663(298 males and 365 females) with a sample size of 249 students from three (3) basic 9 (SS3) secondary schools: One fem ale school (Chude Girls Model Secondary School, Sapele); one male school (Okotie-Eboh Boys' Grammar School, Sapele); and one co-educational school (Zik Secondary School, Sapele) respectively in Sapele Education Zone of Delta State. The sample comprised of 126 students for the experimental groups and 123 students for the control groups. The s tudents' number from co-educational school was 177; and 72 students from single sex s chools. Three sampled schools used were obtained by Purposive sampling techniques. E ach of the sampled schools had between 3 to 6 streams of SS 3 classes; while, two intac t classes were chosen using sampling by balloting assigned experimental and control gr oups. Group A was known for the students who used iPADs in learning mathematics acti vities to nurture their critical thinking; while, group B was for students who used conventi onal method.

The instrument used for collecting data for critical thinking was Mathematics Criti

cal Thinking Assessment Test (MCTAT), which has 27-items questionnaire. The items were structured to measures students' critical thinking abilities using ipads to teach algebra to make inferences, assumptions and reason logically with arguments. The test comprises of five sections: inferences; assumptions; deductions; interpretations; and arguments. The inferences section provide five possible answers as: true, probably true, more information needed, probably false, and false. Assumption section has: assumption made, and assumption not made; while, deduction and interpretation sections have: conclusion follows, and conclusion does not follow; and argument section has: strongly argument, and weak argument. The questions items for inferences (3); assumptions (8); deductions (3), interpretations (6) and arguments (7) respectively. Validation of the instrument was done by two mathematics educators from University of Benin, Benin City and Delta State University, Abraka. The internal consistency reliability of the instrument was determined using Cronbach-alpha yielded 0.62 showing highly reliable. The reason for using Cronbach alpha to analyse the MCTAT instrument is because it has poly-chotomous responses. Analysis of Covariance (ANCOVA) was used in testing the hypothesis; where the PREMCTAT scores of the students' critical thinking in algebra serves as covariates to the POSTMCTAT scores at 0.05 probability level. The research question was answered using mean critical thinking scores.

Results

The result of data analysed are presented based on research question and hypothesis already stated as follows.

Research question: What is the mean critical thinking scores of SS3 mathematics students' taught algebra using ipads compared to their learning with conventional method?

Table 1: Mean critical thinking scores of SS 3 students taught algebra with ipads and those taught with conventional method.

Groups	PREMCTAT X	SD	POSTMCTAT X	SD	Gain Score	No of Students
Experimental (IPADS)	42.32	8.84	50.45	10.06	8.13	126
Control (Conventional)	39.83	10.76	44.37	11.15	4.54	123

Table 1 show that means scores of students in the experimental group (IPADs) in the PR EMCTAT and POSTMCTAT are 42.32 and 50.45 respectively; with gain score of 8.13. On the other hand, PREMCTAT and POSTMCTAT scores of students in the control group (Co nventional) are 39.83 and 44.37 respectively with gain score of 4.54. This shows that m athematics students in the experimental group (those taught with IPADS) achieved highe r in the algebraic critical thinking test than their control group counterparts (those taught with conventional method).

Hypothesis: Significant difference does not exist between critical thinking mean scores o f SS3 students taught algebra using ipad (experimental group) compared to those taugh t with conventional method (control group).

Table 2: ANCOVA summary table for students' critical thinking in algebra by instructional package (IPADS) and gender

Source	Sum of S quares	Df	Mean Squ ares	F	Level of Sign ificance	Decision
Method (IP ADS)	852.47	1	852.47	6.08	0.015	S
Gender	2477.89	1	2477.89	17.66	0.000	S
Gender by Method	3300.28	2	1650.14	11.77	0.000	S
Error	24409.17	246	99.22			

Table 2, show that the calculated F-value is 6.08 at 0.015 level of significant which is les s than 0.05 level of significant set for the study. The null hypothesis is therefore rejected. This invariably means that there is a significant difference between the mean critical thi nking scores of SS3 students taught algebra using IPADS and those taught using conve ntional method. As shown in the table 2, the calculated value of F is 17.66, at 0.000 level of significant. Since 0.000 is less than 0.05 which is the level of significance set for the s tudy, the null hypothesis is then rejected. This implies that a significant difference exists between the mean critical thinking scores of males and females SS3 students taught alg ebra using the IPADS as an instructional strategy. In the same table 2, shown with respec t to the interaction of gender and method (IPADS) on critical thinking in algebra, the calc ulated F-value is 11.77, at 0.000 significant levels. Since the significance level (0.000) is

less than 0.05 which is the level of significance set for the study, the null hypothesis is th erefore rejected. It therefore means that there is a significant interaction effect of gender and IPADS usage on mathematics students' critical thinking skills in algebra as measure d by POSTMCTAT.

Discussions of findings

The findings of IPADS usage of the study shows that mathematics students' in th e experimental group score higher in critical thinking skills in the algebraic test than the c ontrol group. This indicates that the treatment applied produced positive differential effe cts on mathematics students' critical thinking skills. This finding is in consonance with t he results of researches of Hui (2016) and Rosninawati, Suria-Hani, Sofia-Hayati, Rosida yu and Fauziah (2019) on ipads usage in schools shown positive effects in giving encou ragements to mathematics students becoming problem-solvers (critical thinkers) as well as positive experiences for their teachers. Also, Hilton (2018) studied confirmed that the uses of ipads provide positive influence on mathematics students' engagement changin g their attitudes towards mathematics instructions nurturing their critical thinking skills. Furthermore, investigation revealed that there is a significant difference between the me an critical thinking scores of the experimental and control groups due to treatment in fav our of the experimental group (IPADS). This implies that mathematics students in the ex perimental group understood what they had learned faster and responded to questions a sked; quicker, sharper than those in the control group. This is in agreement with Bryant (2 024) that training of students in Science, Technology, Engineering, and Mathematics (ST EM) fields, must go beyond the conventional to encompassed digital literacy, critical thin king and problem-solving skills using IPADS. It indicates that IPADS has shown strong re sults, learning innovative patterns in mathematics students' critical thinking skills as an effective educational method (Mazlan and Siti, 2020). The finding is in lines with Adeline and Hee (2024) and Ingram, Williamson-Leadley and Pratt (2016) results that digital devi ces (IPADS) in education have pervaded our society at a supercharged speed proven to h ave rapid positive effects on students' development; motivated and helping in quick learn

ing whereby increasing their creativity (critical thinking), independence and productivity i n mathematics. However, the research studied of Mazlan and Siti(2020) on effects of iP ad device on students' mathematics achievement and attitudes revealed that the use of i PADs in teaching and learning system does not give significant difference statistically.

Conclusions

Based on the findings of this study, the following conclusions were deduced:

1. IPADS is proven to be effective technological tools in this rapid digital world in schools. These made the experimental groups taught with IPADS have rapid d evelopmental, motivational help to quick learning than the use of the conventi onal method which produced less mathematical productivity. This implies that students who engaged in IPADS usage have higher confidence in their abilities to do mathematical problems easier than their career choice options.
2. The use of IPADS as effective digital devices in teaching algebra in schools m ade students' to understand mathematical questions faster and responded sh arper.

Recommendations

Based on the findings of this research study, the following recommendations wer e made for the mathematics students rapid instructions to be enhance using IPADS:

1. Ipads can easily be modified to adapt to mathematics students need to able t hem gain independence and familiarity with various mathematical instruction s and applications formats. This can increase their confidence and willingnes s to engage with ipads when practice with it continually. Hence, students are more motivated and engaged using their mathematical skills in other areas of study serving as incentives for the mathematics teachers.
2. When ipads is introduce by the mathematics teacher as teaching tool his skill i s expanded to provide additional practice opportunities for mathematics stude nts to demonstrate critical thinking skills in classroom situations.
3. Ipads device had been found to be a source of motivation, stimulus, encourag ement for both teachers and students to learn mathematics topic quicker achi

eving the lesson plans greater than when working with the conventional method. Moreover, mathematics students see ipads as useful and supportive educatio nal tool that facilitate effective communication enhancing collaboration maki ng them to organise their time and studies well.

4. Mathematics teachers should be given professional development continually so that the needed technological knowledge can be inculcated using ipads eff ectively in mathematics classroom environment.
5. Mathematics students higher-level thinking skills, problem based learning, con textual learning and collaborative learning elements needed are stimulated wh en they are apply in mathematics school syllabus in Delta State Ministry of Ed ucation. So adapting ipads very well as technological tools make students to have enough, understanding what they learnt when using their common sense at high level mastery critical thinking skills of evaluation, application, analysin g and creation.
6. Since ipads usage from this study findings had made differences in mathema tics teachers and students critical thinking, it should be promoted, motivated b y the education authorities at all levels as effective tools when both are engag e in it in mathematics classroom.

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