INTEGRATING COMPUTER-ASSISTED INSTRUCTION IN QUANTITATIVE REASONING IN MIDDLE BASIC EDUCATION: AN IMPERATIVE TO REPOSITIONING EDUCATION FOR THE 4TH INDUSTRIAL REVOLUTION

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Abstract: As the Fourth Industrial Revolution (4IR) ushers in rapid technological advancements, the ability of pupils to engage in self-directed learning becomes increasingly crucial. To address the evolving educational landscape, this study investigates the impact of Computer Assisted Instruction (CAI) on enhancing the quantitative reasoning skills of middle school pupils. CAI is a method that leverages computers for instruction, progress tracking, and feedback. The research, conducted in the Enugu Education Zone of Enugu State, employed a quasi-experimental design, targeting 8924 middle basic two pupils across 98 schools during the 2019/2020 academic session. A sample of 490 pupils was selected using stratified, purposive, and simple random sampling techniques. The study utilized the Quantitative Reasoning Achievement Test (QRAT), a validated 40-item multiple-choice test with a reliability coefficient of 0.77 (KR-20). Data were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at a 0.05 significance level. The findings indicate that pupils taught using CAI outperformed those taught through traditional methods. The study recommends the uniform implementation of CAI across schools in the Enugu Education Zone to standardize learning outcomes and ensure equitable instruction in quantitative reasoning amid the 4IR.
Keywords: Computer-assisted instruction, middle basic pupils, quantitative reasoning, 4th industrial revolution

Introduction

Education is a comprehensive method of human learning that involves the transfer of knowledge, the cultivation of skills, and the enhancement of varied capacities. Education is the deliberate act or systematic process of imparting knowledge, skills, and intellectual capacities to individuals, enabling them to think critically, make informed judgments, and prepare themselves and others for adulthood. Etuk, et al (2012) defines education as the process of acquiring new values and abilities that are essential for efficient functioning within society. Good education is very important for all irrespective of age, gender, and race. It promotes lifelong learning among individuals of all age groups, regardless of their caste, creed, religion, or geography. The *National Policy on Education* of the Federal Republic of Nigeria (FRN) mandates the use and enhancement of modern educational approaches throughout every tier of the educational system, to improve the method of instruction and learning (FRN, 2013). The FRN's main objective is to guarantee universal access to a robust fundamental education system. This will equip all citizens with a solid base, enabling them to pursue higher education, acquire specialized skills, and ultimately contribute to the nation's economic, social, and cultural progress.

The 9-Year and revised 9-Year Basic Education Curricula (BEC) in Nigeria is structured as follows: Lower Basic (Primaries 1-3), which focuses on value re-orientation, laying a foundation for critical thinking and developing basic skills. Middle basic (primaries 4-6), here, the curriculum addresses issues such as poverty eradication, entrepreneurship, and the development of scientific and reflective thinking. The final stage which is the upper basic (Junior secondary 1-3) of the 9-year BEC continues to build on the foundations laid in the earlier stages, further developing critical thinking, entrepreneurship, and life skills. The main goal of the 9-Year and Revised 9-Year Basic Education Curricula in Nigeria is to provide a comprehensive education that equips students with the necessary knowledge, skills, and values needed for personal and societal advancement (Federal Ministry of Education [F.M.E], 2012).

Adeosun (2010) identifies inadequate incorporation of Computer-Assisted Instruction (CAI) in the classroom as a key problem leading to the inefficiency of Nigeria's education system. Factors such as poor internet connectivity, little money, limited ICT expertise and abilities, time constraints, and reluctance to change by both instructors and learners. The combination of these problems has hindered the effective integration of CAI in Nigerian classrooms, preventing the full realization of the advantages of technology-assisted educational programs and the overall effectiveness of the education system especially at the early stage, like the middle basic.

According to Nwoye, et al. (2020), middle basic education provides pupils with the fundamental skills that will be the foundation for the rest of their academic career. Unfortunately, quantitative reasoning which exposes the young ones to the basic skills and operations needed for the effective learning of mathematics is dreaded, hated, feared, and massively failed by pupils, especially at the middle basic education level (Hassan, 2014). To tackle this problem of pupils' poor achievement in quantitative reasoning, teachers need to adopt appropriate and new teaching methods in teaching quantitative concepts, especially the basic operations: addition, subtraction, division, and multiplication. Therefore, the objective of the study is to improve the educational achievements and abilities of middle school students, providing them with the essential skills needed to excel in their academic endeavours and future efforts.

At its core, quantitative reasoning encompasses the application of fundamental mathematical operations, such as addition, subtraction, multiplication, and division, to solve problems. (Imuno, 2015). Alio, Nneji, and Eneze (2021) defined quantitative reasoning as an approach to solving problems with an open and flexible mindset, exploring alternative solutions, and devising innovative approaches to find the most effective and efficient answers. The aim of introducing quantitative reasoning as a subject at this early stage of Basic Education is to sharpen the skills of pupils in dealing with figures mentally, which is very necessary for understanding mathematics as a subject, thereby, a step in the right direction. Quantitative reasoning is hinged on mathematical operations as basic arithmetic concepts are explained and simple instructions for the exercises are given. Hence, it is designed to help the learners learn perfect mathematical operations and see relationships between or among different quantities (numbers), thus improving the pupils' logical manipulations of numbers. Unfortunately, basic education pupils, tend to lose interest in quantitative reasoning as a subject and this loss of interest seems to hurt their achievement in this all-important subject.

More worrisome, is the fact that research evidence such as Hassan (2014), Imuno (2015), and Julius (2015) have implicated teacher incompetency and use of unproductive teaching strategies in teaching quantitative reasoning. Also, research evidence from Olayinka (2015), specifically faulted some of the methods of teaching like the expository and lecture method. In summary, implementing CAI in the field of mathematics can improve learning results, foster motivation and engagement among pupils, and equip students for accomplishments in the digital world. Through the utilisation of technology, educators may establish exciting and collaborative learning environments that enable students to develop proficiency in mathematics and enhance their critical thinking abilities to suit the current advancement in technology.

The Fourth Industrial Revolution is characterised by the convergence of advanced technologies including artificial intelligence, robots, the Internet of Things (IoT), 3D printing, nanotechnology, biotechnology, and quantum computing (Ciolacu et al., 2017). By providing more efficiency, personalisation, and connectivity, these technologies are revolutionizing various sectors. Teaching methods must be adapted in response to the Fourth Industrial Revolution. Teacher training needs to be reoriented to ensure that students develop the ability to apply, assess, and generate knowledge based on what they're taught in classrooms, rather than simply memorizing and understanding the content of the curriculum (Profutro, 2022).

The advent of the (4IR) has bestowed upon teachers a momentous task: to develop educational methodologies that can unleash the unique potential of each student and equip them with the necessary abilities to change the future through innovative practices facilitated by technology. The emergence of the 4th Industrial Revolution is compelling educators to adapt their teaching methodologies to facilitate individualised learning that fosters innovative thinking and problem-solving skills, while also allowing for increased opportunities for one-on-one instruction.

As technology demands are evolving so quickly, students need to understand how to learn on their own. Incorporating technology, educators need to shift their role to become facilitators of learning beyond their areas of expertise, allowing students to pursue their interests and acquire additional skills (Ayanwale et al, 2022). This calls for promoting activity types and analytical kinds of teaching and learning such as Computer Aided Instruction (CAI) strategy. CAI can be a highly effective mode of instructional delivery in mathematics education, especially in the element of the Fourth Industrial Revolution (4IR). As societies strive to keep pace with these changes, integrating innovative technological tools in education becomes crucial. One such tool is CAI, which refers to the use of computers to deliver, support, and enhance the educational experience. (Assante, 2019).

The CAI strategy utilizes a range of computer-based methods, including drills and practice, tutorials, and simulations, to improve the learning process (Sedega, et al, 2017). Suleman, et al (2017), averred that CAI is an instructional strategy that leverages the capabilities of computers to both communicate instructional content and evaluate student learning outcomes. Gana (2013) defined instructional technology as a comprehensive concept that incorporates a diverse array of computer applications and technologies utilized in educational environments. CAI encompasses the utilization of computers to aid and improve the process of teaching and learning. This process involves a diverse array of activities, including data training, drills and applications, experiments, instructive activities, instructional management, database construction, computer programming, text editing, and other applications. In summary, the utilization of Computer-Assisted Instruction (CAI) in mathematics education can enhance learning results, stimulate involvement and drive, and equip students for achievement in the digital era (Olayinka 2015). By leveraging technology, instructors may create dynamic and interactive learning environments that empower students to cultivate sophisticated mathematical proficiency and elevate their critical thinking prowess.

The researchers utilised a sort of CAI known as information instruction in this study. This CAI method facilitates the acquisition of the specific knowledge that the learner requires. Therefore, the computer can function as an inquiry officer by responding to students' inquiries using the stored information it possesses. The primary objective of this Computer-Assisted Instruction is to furnish vital information necessary for the acquisition of concepts and skills. In this context, the term "Computer Assisted Instruction" refers to the teacher's use of a computer during instruction to aid students in learning the course material and setting attainable goals for the future.

Another variable of interest to the researcher in this study is the influence of school ownership on middle basic education pupils' achievement in quantitative reasoning when taught with Computer Assisted Instruction. School ownership in this work is categorized into two viz; public and private schools. Public schools, also known as state/federal government schools refer to schools owned, funded, and overseen by the state or federal government.

Statement of the Problem

Computer Assisted Instruction strategy ranks very high among innovative teaching strategies that have received consistent and wide recommendations from modern educators. However, there are still conflicting reports on the effectiveness of Computer Aided Instruction on the entire teaching and learning process, especially, at the basic education levels. Since there is no definitive conclusion, there is a need for more studies in this area. Furthermore, the proliferation of private schools in Nigeria today has raised more questions than answers. There is no consensus among research studies about the impact of school type (public/private) on the academic performance of elementary school students in many disciplines, including quantitative reasoning. These discrepancies influence the selection of this study. The research topic of this study is: What is the impact of Computer Aided Instruction Strategy on the academic performance of middle basic education pupils in quantitative reasoning, specifically about their educational setting (public/private)?

Purpose of the Study

This study aimed to investigate the influence of integrating computer-assisted instruction (CAI) on enhancing mathematical reasoning abilities in middle school pupils, in response to the changing environment of the Fourth Industrial Revolution (4IR). In specific terms, the study investigated:

1. The influence of computer-assisted instruction (CAI) on the scholastic achievement of middle school pupils in the domain of mathematical reasoning.
2. The effectiveness of Computer-Assisted Instruction (CAI) on the educational achievement of learners in middle school in mathematical reasoning, taking into account their school type (public or private).

Research Questions

1. What is the difference between the mean achievement scores of pupils who learned mathematical reasoning through the computer-aided instruction approach (the experimental group) and students who learned the same material through the traditional method (the control group)?
2. What are the mean academic achievements of pupils enrolled in computer-assisted instruction courses in quantitative reasoning in both public and private schools?

Hypotheses

The research hypotheses were assessed at a significance level of 0.05.

1. There is a lack of statistical significance in the mean academic achievement scores of pupils who received training in quantitative reasoning using CAI compared to those who were taught using the traditional technique.

2. There is no significant difference in the mean scores of pupils from public and private schools who were taught mathematical reasoning using Computer-Assisted Instruction.
3. There is no notable correlation between the manner of teaching and the type of school on the scores of pupils' achievement in quantitative reasoning.

Methodology

The study implemented a quasi-experimental design, employing a pretest-posttest strategy with non-equivalent groups. The entire classes were randomly assigned to either the control group or the experimental group for this study. Although the groups may not be identical, the researcher has the advantage of being cognizant of the pretest scores. The discrepancy in scores between the pretest and posttest can be used to determine the influence of the independent variable. The study was conducted in the Enugu Educational Zone situated in Enugu State.

The sampling approach employed stratified, purposive, and basic random sampling strategies. The study included all children in Middle Basic Two Education in the 98 public and private (registered) schools in the Enugu Education Zone of Enugu State. The total number of children was 8924. The population comprises 6763 pupils in public schools and 2161 pupils in private schools. The study sample consisted of 490 Middle Basic II (Primary Five) Education Pupils, with 284 pupils attending public schools and 206 pupils attending private institutions. Moreover, the sample comprised 255 pupils from the trial group and 235 pupils from the control group. Twelve complete classes, comprising both public and private institutions, were chosen at random from the three Local Government Areas in the Enugu Education Zone.

The Quantitative Reasoning Achievement Test (QRAT) was utilized as the data-gathering instrument. The researcher designed the Quantitative Reasoning Achievement Test (QRAT) with 40 multiple-choice items. These questions were selected from the quantitative reasoning topic region that was looked at in this study. QRAT underwent both face and content validity tests; reliability of .77 was determined utilizing the Kuder- Richardson 20 Formula approach; each question contained four options (letters A through D), three of which were distractions, and only one of which was the right answer (the key).

There were both pretests and posttests given to pupils using the instrument. After the pretest, the researchers provided the quantitative reasoning teachers in the selected schools with a prepared lesson plan. The teachers used this plan to experiment. The experiment involved teaching participants quantitative reasoning using Computer-Assisted Instruction (CAI), whereas the control group was taught the identical material using the expository method. The experiment was carried out within regular school hours, following the school's teaching schedule, and spanned for two weeks. After experimenting, the teachers administered the post-test to both groups. The results from both the initial and final tests were meticulously documented and appropriately categorised.

The research inquiries were addressed by employing the mean and standard deviation, while the hypotheses were tested by utilising Analysis of Covariance (ANCOVA) at a significance level of 0.05.

Result

Research Question 1**:** What is the difference between students who learned quantitative reasoning through the Computer Aided Instruction approach (the experimental group) and students who learned the same material through the traditional method (the control group)?

Table 1: *Students' achievement levels in the control and experimental groups.*

Group	N	Pretest		Posttest		Mean	Mean Gain
		Mean	SD	Mean	SD	Difference	Difference
Experimental	255	23.13	5.25	70.47	0.57	47.34	22.93
Control	235	22.71	4.80	47.12	1.33	24.41	

NB: N= number of respondents, SD = standard deviation

Table 1 shows that the experimental group's pretest achievement score was 23.13, with a 5.25 standard deviation. Conversely, the control group recorded a mean score of 22.71 with a standard deviation of 4.80. In the post-test, the experimental group's mean achievement score was 70.47, with a standard deviation of 0.57. Conversely, the control group had a mean score of 47.12 with a 1.33 standard deviation. Additionally, the average gain in scores between the two groups differed noticeably by 22.93.

***Research Question 2*:** What are the mean academic achievements of pupils enrolled in computer-assisted instruction courses in quantitative reasoning in both public and private schools?

Table 2: *Achievement scores in the pretest and posttest for both public and private schools.*

School Type	N	Pretest		Posttest		Mean	Mean Gain
		Mean	SD	Mean	SD	Difference	Difference
Public (Experimental)	130	22.51	5.01	70.50	0.60	47.99	0.02
Private (Experimental)	125	23.00	5.55	71.01	0.51	48.01	

The pretest mean accomplishment scores and standard deviations for public schools were 22.51 and 5.01, respectively, according to the above table. The pretest mean achievement scores and standard deviations for pupils in private schools were 23.00 and 5.55, respectively. In the same way, pupils in public school’s post-test mean accomplishment scores and standard deviations were, respectively, 70.50 and 0.60. The post-test mean achievement scores and standard deviations for pupils in private schools were, respectively, 71.01 and 0.51. There was no noticeable distinction between the achievements of pupils in the two types of schools, as the difference between their mean achievement scores was extremely small.

Table 3: Analysis of covariance (ANCOVA) for hypotheses 1, 2, and 3 on pupils Achievement.

Source	Type III sum of squares	DF	Mean Square	*f*	Sig.	Decision
Corrected Model	1011.291	3	337.097	2.46	.000	S (Reject Hypothesis)
Intercept	103076.927	1	103076.927	750.91	.000	
Teaching Strategy	1109.104	1	1109.104	8.08	.000	
School Type	980.611	1	980.611	7.14	1.771	N/S (Do not reject hypothesis)
Strategy*School type	770.401	1	770.401	5.611	3.061	

Error	66311.687	483	137.291		N/S (Do not Reject Hypothesis)
Total	173260.021	490			

The students' ANCOVA success scores are displayed in Table 3. The calculated f-value of 8.08, which is less than the specified level of 0.05 for this study, is statistically significant in terms of teaching strategy at a significance level of.000. As a result, the study was significantly impacted by the teaching method. Because there is a significant difference in the experimental and control groups' average scores for Quantitative Reasoning accomplishment, hypothesis 1 is rejected. The computed f-value of 7.14 for the type of school (public/private) is statistically noteworthy at a level of significance of 1.771, which is higher than the study's predefined level of 0.05. As a result, there was no discernible effect of school ownership on students' academic achievement in this study. Since there was not a statistically significant distinction in the average Quantitative Reasoning achievement scores between students from private and public schools in either the experimental or control groups, hypothesis 2 is not rejected.

The estimated f-value of 5.611 is statistically significant at a level of 3.061, which is higher than the intended significance level of 0.05 set for this research in terms of interaction (i.e., the teaching technique of school ownership). Therefore, the interaction effect was found to be insignificant, indicating that there was no substantial relationship between the teaching style and school type in the accomplishment of Middle Basic Education learners in Quantitative Reasoning. Hypothesis 3 is thus not refuted, as previously stated.

Discussion of the Findings

Research question one sought to know the mean achievement scores of the pupils in both experimental and control groups in both pretest and post-test. It was found that the mean pretest scores of both groups did not differ significantly. This suggests that both groups had similar entry behaviour and achievement ability. Also, the wide gap between the mean pretest scores and the mean posttest scores showed that learning took place in both groups. The result further indicated that there was a significant difference between the achievements of the groups in favour of the experimental group (pupils taught with CAI) who achieved higher than the control group (pupils taught with the lecture method).

According to the study's findings, there was a significant achievement gap between the two groups, with the experimental group—who received instruction via computer assistance—outperforming the control group, which received traditional instruction. Olayinka (2015) asserted that traditional techniques are less effective than computer-aided instruction (CAI) at improving children's academic achievement. This study supports the claim. Academic achievement, in the words of Olayinka (2015), is the expansion of students' knowledge brought about by their involvement in a program or learning activity. Using this standard as a guide, it is safe to say that the pupils' success was a direct result of the care they got.

In addition, unnecessary variables were effectively managed. Consequently, this suggests that CAI resulted in greater academic success compared to the traditional strategy. Interestingly, the standard deviation of the experimental group was significantly lower than that of the control group. This shows that the group who received computer-assisted instruction (CAI) either had very few or no exceptionally high results. As a result, rather than being impacted by the achievements of a small number of students within the group, the mean score fairly represents the total accomplishments of the entire class.

Conclusion and Recommendations

The study found that the computer-assisted instruction technique was superior to the traditional method of instructing middle-basic education pupils in quantitative reasoning.

The research's conclusion led to the following recommendations:

1. In intermediate basic education, teachers in all public and private schools in Enugu State shall use Computer-Assisted Instruction (CAI) to teach mathematical reasoning.
2. Computer-aided instruction (CAI) in microteaching and teaching practice exercises should be given top priority in Nigerian teacher education curricula. This would provide pre-service teachers with more useful knowledge while they are being trained.
3. All educational institutions, public and private, should either employ a programmer or mandate that their computer teachers take a course on computer programming.

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