

Effect of Virtual Class on Academic Performance in Thermal Physics Among Physics Students in Colleges of Education in Katsina State

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Abstract: This research examined the effectiveness of virtual mode of contact, against the conventional distance learning practices characterized by physical classroom, papers and chalkboard, in delivering quality physics teaching and learning outcomes. The population of study comprised of all NCE II Science students, with age range (17-25 years) of Federal College of Education Katsina (FCEK) and Isah Kaita College of Education (IKCOE), Dutsin-ma, Katsina State, selected from subject areas of Physics, computer and Integrated science, with a target population of 240 students. A total sample of 120 students, which is 50% of the targeted population, was selected using stratified random sampling, where each department represented a stratum. They were randomly divided into the experimental (representing conventional classes) and control (representing virtual classes) groups. The 120-sample size comprised of 80 male and 40 female. The instrument for the data collection is a Physics Cognitive Achievement Test (PCAT), which consisted of 100 objective items drawn from some concepts of physics, which include heat and temperature, laws of thermodynamics, linear and volume expansion. The PCAT test was skillfully designed to assess higher-order skills such as application, analysis, and evaluation. Results shows that students in virtual classes have higher mean achievement (52.03) than those in the conventional classes whose mean achievement is 45.03. Similarly, 50% and 57.5% of male and female participants respectively scored below mean scores of 46 and 41 in the conventional classes. Similar scenario is seen repeated in virtual classes, suggesting that the different contact mode of learning is not gender discriminative. Recommendations were provided for advancing and revolutionizing distance learning option through a complete institutionalization of virtual option in Nigerian tertiary institutions, especially in a highly security-challenged north western Nigeria.

Keywords: Distance-Learning; Conventional; Virtual-Learning Contact, Learning-Achievements.

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I. INTRODUCTION

The rapid advancement of digital technology has significantly transformed the landscape of education worldwide, and has become increasingly relevant in facilitating teaching and learning beyond the traditional classroom setting, introducing innovative approaches such as virtual learning environments, and virtual classes which are enabled by internet-based platforms and digital tools. This shift has been further necessitated by the global disruption caused by the COVID-19 pandemic, which compelled

educational institutions to adopt remote learning strategies to ensure continuity in academic activities [8]. As a result, virtual instruction has evolved from a supplementary tool to a central mode of knowledge delivery in many institutions.

The Internet is now playing a bigger role in our lives and dictating how we live, socialize, teach, and learn. As the Internet develops into a main educational tool, online education offers educators and learners access to numerous resources. During the last decade online education of various kinds, often called distance education or web-based

education, has become a normal part of many university programs. Online teaching and learning is designed to reach and engage the modern learner on one-to-one basis anywhere, anytime. A popular form is the Massive Open Online Courses (MOOC), which have grown to involve many researchers and research institutions [17]. The reasons for offering online course include easy and convenient access for students, higher degree completion rates, and the appeal of such courses to nontraditional students. However, notable barriers to the adoption of online courses include lack of faculty commitment and high costs of implementation and delivery of the courses [18].

In the context of physics education, the integration of virtual classes presents both opportunities and challenges, as almost all its concepts are dreaded with high-level abstractions by almost all of its beginner-learners, and therefore requires deep conceptual understanding that is supported by practical demonstrations and problem-solving skills. Virtual learning platforms can provide simulations, visualizations, and interactive resources that may enhance students' comprehension of abstract Physics concepts [10]. However, limitations such as inadequate access to digital devices, unstable internet connectivity, and reduced hands-on laboratory experiences may hinder effective learning outcomes, especially in developing regions [1].

Colleges of Education in Katsina State play a crucial role in training future educators, making the quality of instruction in subjects like Physics particularly important. The adoption of virtual classes in these institutions raises important questions regarding their effectiveness in improving students' academic performance. While some studies suggest that virtual learning can enhance engagement, flexibility, and self-paced learning [11], others indicate that it may lead to decreased motivation and limited interaction between instructors and students, particularly where technological infrastructure is inadequate [6].

Studies by [5] showed that students that were engaged through the virtual physics laboratory performed better than students taught in the traditional physics laboratory. In addition, the study also showed gender disparity in academic achievement. [9], adopted, mixed research methodology including quasi-experimental design, achievement test, participatory observation, and semi-structured interviews. Two groups of students were selected: an experimental group (45 students) and control group (45 students). The results of the study showed that substituting face-to-face theoretical preparation in the general physics lab is at least equally effective as using virtual experiments. Students with virtual components acquired deeper understanding of physics concepts and were better prepared for carrying out real experiments. Attending online videos spared students' time and provided them with a more flexible and rich learning environment.

However, while [2] used descriptive statistics based on the CGPA of graduating students to show that the two modes of study (physical and virtual classes) do not differ from one another, [7], [19], [20] statistically compared teacher hours

devoted to advising students and showed that students prefer the traditional classroom study over distance education. [12], studied the Effect of Gender and Teaching Methods on Academic Success in Virtual Reality to Reduce Gender Disparity in Technology. Their result showed that there was no significant difference between the achievements of male students in both groups, while the female students in indirect instruction classes achieved significantly higher scores than their counterparts in direct instruction classes. Similarly, using

Descriptive, Analysis of variance (ANOVA) and independent t-test statistics, [13] showed in their result that there is no gender disparity in students' performance.

With these different perspectives relating to effectiveness of physical and virtual mode of learning contact, it becomes imperative to examine the specific impact of virtual and physical classes on students' academic performance especially in the midst of the prevailing economic hardship in northern Nigeria. Therefore, in view of the prevailing economic challenges faced by north western Nigeria, this study seeks to investigate the effectiveness of virtual classes, as against the physical classes, on the academic performance of Physics students in some selected areas in Katsina State.

➤ *Statement of the Problem*

Technology has come to play a vital role in advancing students' academic performance; however, many educators and educational systems still persevere on regular classroom teaching and learning, which has led to some of the challenges faced by working class learners. Results of several studies (e.g [2]; Beard and Harper, 2004; Tomei, 2006; Dellana, Collins and West, 2000) have shown that a vast majority of adult learners preferred distance learning, but it is not clear whether the type of distance learning they sought are those that still involve physical classes, inform of satellite campuses. In present-day north-western Nigeria facing challenges of insecurity of all kinds, namely hunger, insurgency and banditry, distance learning option shouldn't only be for convenience, but for safety. It is in this regards that this paper seeks to investigate virtual mode of learning contact so as to determine its effectiveness in delivering quality learning outcomes in physics education.

➤ *Aims and Objectives*

The study investigates the virtual mode of learning contact with the aim of determining its effectiveness on learning outcomes against those of the conventional mode.

The specific objectives are as follows;

- To determine and compare the mean academic performance of students in conventional and virtual classes in a adequately constructed physics achievement test.
- To assess the impact of virtual class teaching versus physical class teaching.

- To determine and compare the mean difference in academic performance between male and female students in the conventional and virtual classes.

➤ Research Questions

- To what extent is the mean academic performance of the students in physical classes compared to those in virtual classes?
- To what extent is the mean difference in academic performance between male and female students in the virtual classes and those in the physical classes

➤ Research Hypothesis

- There is no significant mean difference in the academic performance of students in the physical classes compared to those in virtual classes.
- There is no mean difference in academic performance between male and female students in the physical classes and those in the virtual classes.

➤ Limitations of the Study

Despite the relevance of this study, certain limitations may affect its outcomes. One major limitation is the issue of inadequate access to reliable internet connectivity and digital devices among students, which may influence their participation in virtual classes and consequently their academic performance. Additionally, the study is constrained by limited sample size, as it focuses only on the selected Colleges of Education within Katsina State, which may affect the generalization of the findings.

II. METHODOLOGY

➤ Population of the Study

The population of the study comprised of all NCE II Science students, with age range (17-25 years) of Federal College of Education Katsina (FCEK) and Isah Kaita College of Education (IKCOE) Dutsin-ma, Katsina, selected from subject areas of Physics, computer and Integrated science, with a target population of 240 students.

NCE II students were selected because they have sufficient foundational knowledge of Physics, specifically thermal physics, and they have smart phones, and are developmentally ready to participate in cognitively and physically demanding tasks, and are not under the exam pressure associated with NCE III, making them suitable for experimental studies.

➤ Sample and Sampling Technique

A total sample of 120 students, which is 50% of the targeted population, was selected using stratified random sampling, where each department, namely physics, computer science and integrated science, represented a stratum. They were randomly divided into the experimental or control group. This sampling procedure ensured proportional representation, minimized selection bias, and improved

generalizability. The 120-sample size comprises of 80 male and 40 female students.

➤ Research Design

A quasi-experimental design involving pre-test and post-test was used in the study. The sampled population was divided into two groups, namely experimental (administered via conventional mode of learning contact) and the control group (administered via the virtual mode). The experimental group received instructions through the conventional lecture methods and strategies, while the control group was taught using a well and skillfully-designed teaching strategies, hybrid with simulations. The whole exercise lasted for seven (7) weeks, and was divided into two phases. The first six (6) weeks were designated for lectures; three (3) weeks each for each group. The seventh (7) week was for the physics cognitive achievement test, PCAT, which was administered to both groups with the aid of some research assistants. Finally, the scripts were marked and graded using percent scale.

➤ Research Instruments

The instrument for the data collection is Physics Cognitive Achievement Test (PCAT), which consisted of 100 objective items drawn from some concepts of physics, which include heat and temperature, laws of thermodynamics, linear and volume expansion, Heat capacity. The PCAT test was skillfully designed to assess higher-order skills such as application, analysis, and evaluation in line with Bloom's revised taxonomy [15], [4].

➤ Validation of the Instruments

Experts in Physics Education and in Measurement and Evaluation validated the research instrument to ensure content and language clarity, relevance of items, curriculum alignment, cognitive level appropriateness, and coverage of expected learning outcomes. Thus, the experts certified the PCAT instrument as having strong content and construct validity.

➤ Reliability of the Instruments

Reliability was established through a pilot study of 30 NCE II students from a department not included in the main sample, with a PCAT reliability coefficient of 0.78. This value exceeds the 0.70 threshold recommended for educational research [3].

➤ Method of Data Collection and Analysis

The researchers personally handled data collection with assistance from trained Physics lecturer and ICT Staff of both institutions. PCAT was administered under examination-like conditions to the experimental group, while those of control group were administered via online with assistance of the ICT of the institution. Finally, the scripts were collected immediately to avoid manipulation or loss.

The raw collected was analyzed using mean statistic in order to examine the performance and engagement levels. Finally, using Pearson's correlation coefficient and regression statistics, correlation and regression analysis, as well as Kolmogorov-Smirnov test (K-S test), were carried out

on the data to find the nature and strength of the relationship among parameters.

➤ Data Presentation and Interpretation

We show the distribution of achievement scores of all participants, in both physical (otherwise referred to as

conventional mode) and virtual contacts in figure1. Obviously, the distribution is continuous for both mode of contact, with those in the physical trailing the virtual mode in the lower region.

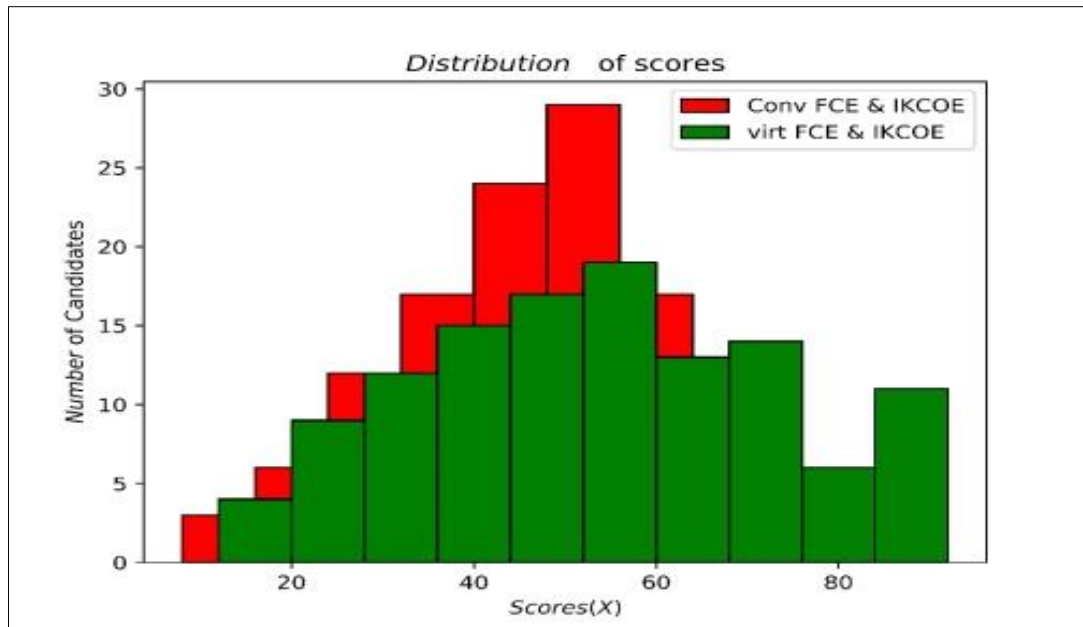


Fig 1 Histogram Distribution of Achievement Scores

However, the range of scores is different for the different mode of contact, being higher for the virtual than in the case of the conventional contact. The cumulative

distribution of scores for the whole participants, in the different contact mode, is shown in figure 2.

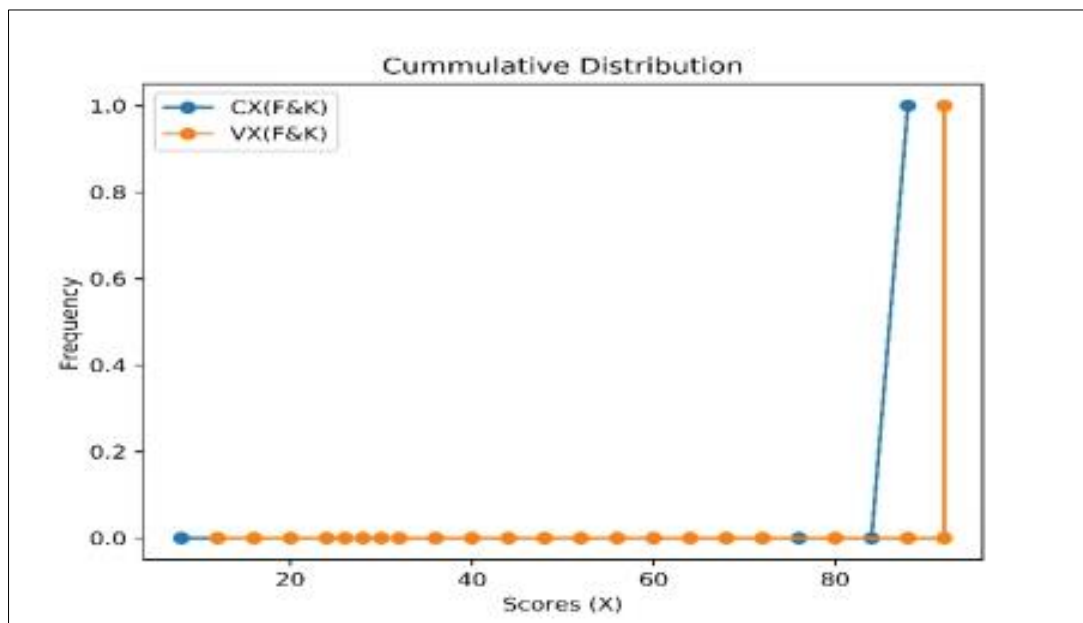


Fig 2 Cumulative Probability Distribution of Scores in Virtual and Physical Contact Mode

The mean performance (shown in table 1) is also significantly different for the different mode of contact, 45.03 and 52.03, for the conventional and virtual respectively. About 57% of the total participants scored below the mean in

the virtual mode, compared to about 62% of the total participants in the conventional mode that scored below the mean score.

Table 1 Mean Performance of Participants in Achievement Test for All participants

MODE	N	$\bar{X}$	$N < \bar{X}$	$\% N < \bar{X}$	$N > \bar{X}$	$\% N > \bar{X}$
CONV.	120	45.03	62	51.67	58	48.33
VIRT.	120	52.03	57	47.5	63	52.5

Table 2 Mean Performance of Participants in Achievement Test for Male and Female Participants

MODE	MALE						FEMALE					
	N	$\bar{X}$	$N < \bar{X}$	$\% N < \bar{X}$	$N > \bar{X}$	$\% N > \bar{X}$	N	$\bar{X}$	$N < \bar{X}$	$\% N < \bar{X}$	$N > \bar{X}$	$\% N > \bar{X}$
CONV.	80	46.85	40	50	40	50	40	41.20	23	57.5	17	42.5
VIRT.	80	54.28	32	40	48	60	40	47.90	16	40	24	60

A simple Kolmogorov-Smirnov (K-S) test, at 5% significance shows that the hypotheses that the performance scores of participants in the different contact mode are the same is rejected with p-value ~ 0.006 . We interpret this result to mean that the underlying performance differences in the two different modes of contact are not driven by similar performance indices, namely learning environment, variations in learning resources, beliefs and value systems, background status, access to basic supporting learning

infrastructures, social climate, neighborhood characteristics, etc.

Similarly, we show the distribution of scores for the male and female participants in the physical mode of contact in figure 3 (a & b). Although the male counterpart apparently occupies the upper region of scores than the female, however the distribution is continuous, with male covering wider range than the female.

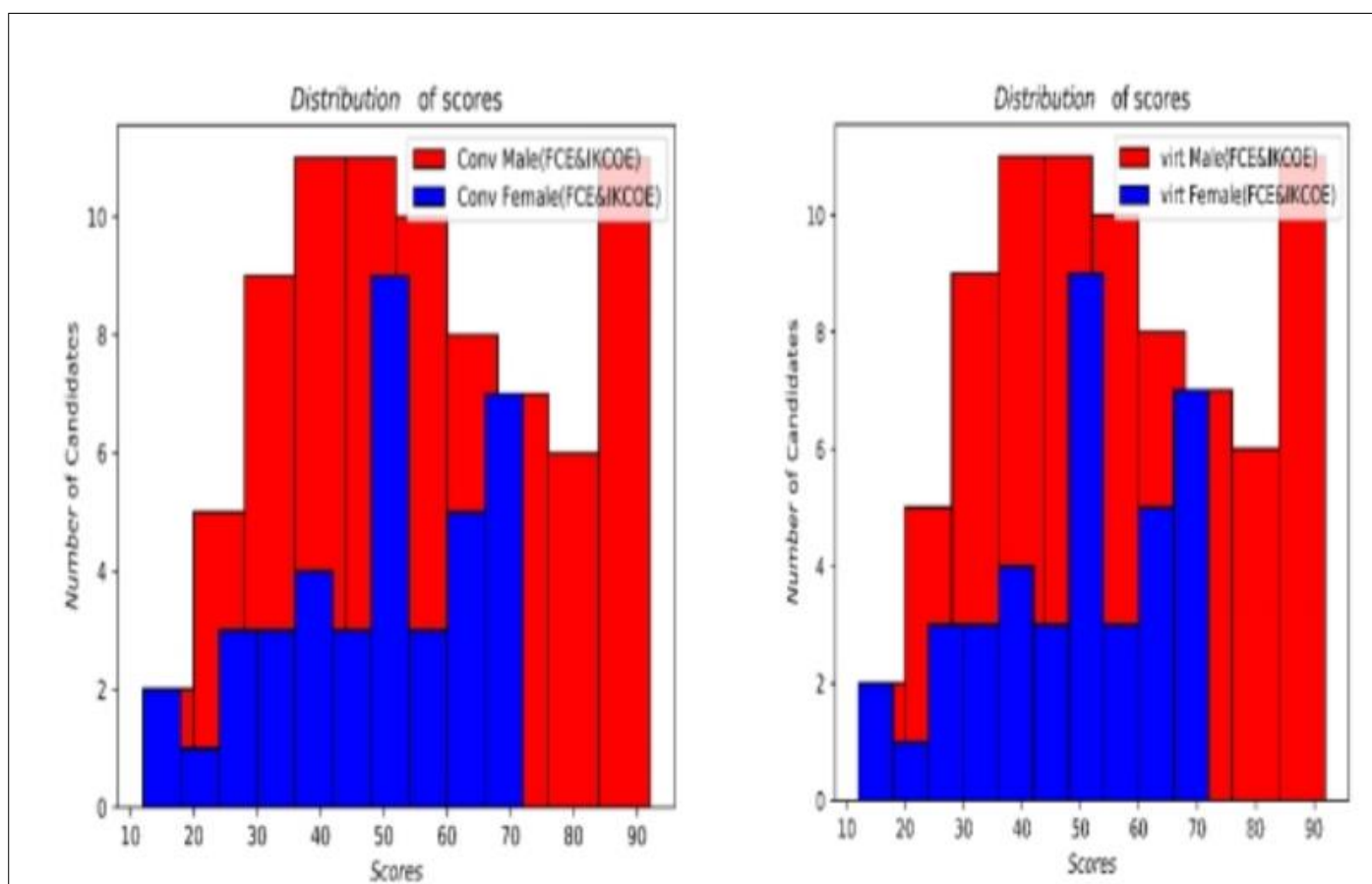


Fig 3 Histogram Distribution of Scores for the (a) Male and Female Participants in Conventional Contact Mode (b): Male and Female Participants in Virtual Contact Mode

Similar scenario also occurs in the case of virtual contact mode, as shown in figure 3b. On the average, performance scores for male and female in the physical mode

are 46.85 and 41.20 respectively, and 54.25 and 47.90, respectively in the virtual mode. The cumulative probability distribution is shown in figure 4.

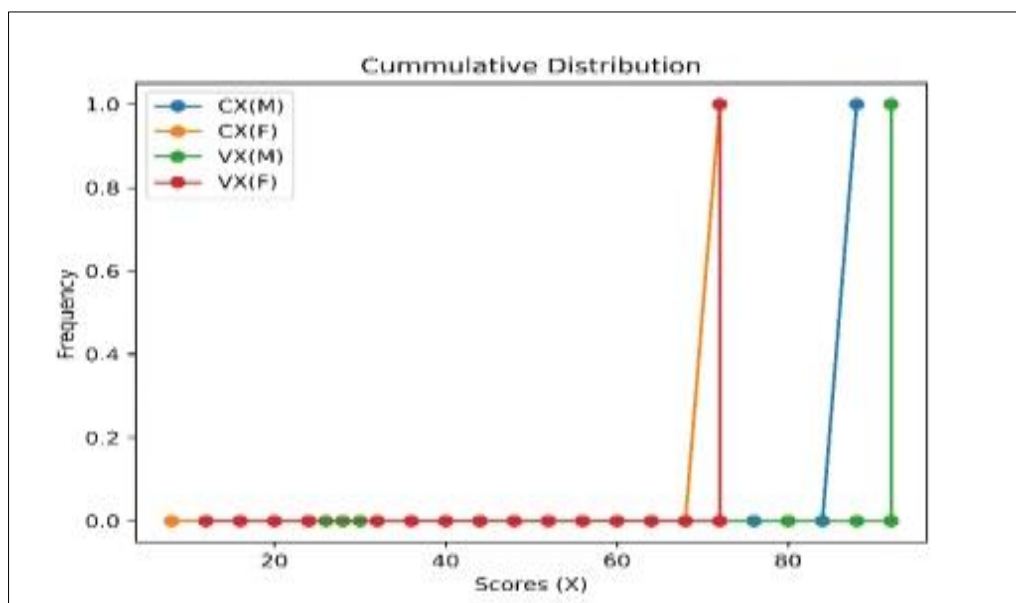


Fig 4 Cumulative Probability Distribution of Scores in Virtual and Physical Contact Mode

In each case, a simple K-S test at 5% significance failed to reject the hypotheses that gender mean performance differ significantly in the different mode of contact, with $p \sim 0.45$ and $p \sim 0.16$ respectively. We interpret this result to mean that the different contact mode is not gender discriminative, which means that they cannot determine the underlying gender performance difference.

III. DISCUSSION

Distance-learning option (DLO), typically operated by most institutions in Nigeria in form of satellite campuses, is characterized by conventional mode of teaching and learning which is usually by physical contacts, and in most cases defying the convenience sought by working class learners. In recent times, DLO in highly security-challenged north western Nigeria is not only for convenience, but for safety. Therefore, the need for DLO that is pure virtual has become imperative in these regions.

As clearly shown in the continuous distribution of achievement scores of all participants, in figure 1 and table (1&2), there is significant difference in academic performance of students in the different modes of contact, namely conventional (or physical) and virtual classes, with students in virtual classes having higher mean achievement (52.03) than those in the conventional classes whose mean achievement is 45.03. The higher mean performance of the virtual group can be attributed to the intrinsic convenience associated with online learning which is easily facilitated by ICT supportive simulations and other learning resources. This is clearly reflected in the results as only about 47% of the total participants in virtual classes scored below the mean compare to about 52% of their counterparts in the conventional classes having scores that are below the mean. A simple Kolmogorov-Smirnov (K-S) test, at 5% significance shows that the hypotheses that the performance scores of participants in the different contact mode are the same is rejected with p -value ~ 0.006 . If this is the case, this result

suggests that the underlying performance differences in the two different mode of contact are not driven by similar performance indices, such as learning environment, variations in learning resources, beliefs and value systems, background status, access to basic supporting learning infrastructures, social climate, neighborhood characteristics. The result clearly contradicts [2] whose result shows that the two modes of study (physical and virtual classes) do not differ from one another, and the findings of (Beard and Harper, 2004; Tomei, 2006; Dellana, Collins and West, 2000) which shows students' preference of traditional classroom over distance learning option.

Furthermore, the distribution of achievement scores between male and female participants, clearly shown in figure 3 and table 1b, shows that their performance are almost indistinguishable, with 50% and 57.5% of male and female participants, respectively scored below mean scores of 46 and 41 in the conventional classes. Similar scenario is seen repeated in virtual classes. A simple K-S test at 5% significance failed to reject the hypotheses that gender mean performance differ significantly in the different mode of contact, with $p \sim 0.45$ and $p \sim 0.16$ respectively. This result partly disagreed with the findings of [12], that while there is no significant difference between the achievements of male students in both groups, the female students in indirect instruction classes achieved significantly higher scores than their counterparts in direct instruction classes. However, the result is consistent with the findings of [13] that there is no gender disparity in students' performance across the different learning contacts.

IV. CONCLUSION

This study investigated the effectiveness in delivering quality physics teaching and learning outcomes of virtual mode of contact, against the conventional distance learning practices characterized by physical classroom, papers and chalkboard. North western region of Nigeria, and Katsina

state in particular is highly facing insecurity in recent times, so much that convenience isn't the only desire, but safety the prospective learners. The research employed a quantitative data on students' academic performance which involved analyzing exam/test scores, assignment grades and overall course grades of students enrolled in physics courses in both Physical and virtual classes. A descriptive statistic such as mean was adopted and regression statistics (K-S test). The results show that mean achievement of students in the virtual mode of contact is better than that of conventional mode. Furthermore, the results also show that the different contact mode is not gender discriminative, which means that they do not determine the underlying gender performance difference.

RECOMMENDATION

Based on the results, it is highly recommended that all institutions of higher learning in north western Nigeria should begin to plan for complete virtual learning options as panacea not only to the convenience of working-class adults, but as safety measures in an unsecured region. In this regard, the government at all levels also need to introduce educational policies for virtual classes where learning can be done remotely, especially at this time of high living cost due to poor economy, and high risk of insecurity.

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