

## Facilitating Secondary School Students' Achievement in Circular Motion Concept Using Computer-Supported Team-Assisted Individualization Strategy in Mangu Local Government Area, Nigeria

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### Abstract

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This study examined facilitating secondary school students' achievement in circular motion concept using computer-supported team-assisted individualization strategy (CTIS) in Mangu local government area, Nigeria. The pre-test, post-test non-equivalent control group quasi-experimental research design was used. The sample size of 66 students offering Physics from one intact class each in four schools, obtained by the purposive and simple random sampling techniques, was used for the study. The experimental group consisted of 19 male and 15 female students while the control group consisted of 22 male and 10 female students. The instrument developed and used to gather data was the Circular Motion Achievement Test (CMAT) which comprised 30 multiple-choice items in the concept of circular motion in Physics. The reliability coefficient of CMAT, using the KR-20 on SPSS Version 26, was determined as 0.90. The mean was used to answer three research questions raised for the study and the t-test of independent samples was used to test the three formulated hypotheses at  $\alpha = 0.05$  level of significance. Findings from the study indicated that students taught using CTIS achieved higher in Physics than those taught using conventional expository strategy (CES). It was also revealed that the CTIS is favourable, in terms of achievement, to both gender and in all schools irrespective of location. One of the recommendations proffered was that curriculum planners should be encouraged to incorporate CTIS in secondary school Physics curriculum.

**Keywords:** *Circular motion, Computer-supported team-assisted individualization strategy, Physics, Students' achievement, Students' gender, School location*

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### **Background to the Study**

Physics is one of the science subjects which students begin to offer at the senior secondary school level of education in Nigeria. Abdu-Raheem (2012) defined Physics as the study of matter in relation to energy and Nelkon (2013), defined it as a science subject which studies non-living matter and the behaviour of that matter in relation to energy. Josiah (2020) opined that this implies that Physics provides the relationship between inanimate matter and energy, which forms a basis for technologically-enhanced human livelihood. Nigerian Educational Research and Development Council [NERDC] (as cited in Josiah, 2020) were of the view that Physics as a subject is critical for effective living in the contemporary science and technology world. Its knowledge is very crucial for effective livelihood in this 21<sup>st</sup> century and beyond, given its vast application in medicine, agriculture, engineering and other fields. Usman, Simyyap and Fasanya, (2019), therefore, noted that it is necessary that students who offer Physics in secondary schools, where its foundation is taught, be provided with the opportunity to acquire knowledge and skills offered by the subject. This is in line with one of the national educational goals of Nigeria (Federal Republic of Nigeria, 2014) which, in part, states that students are required to be equipped with the appropriate skills to enable them contribute to the growth of their nation. In other to achieve this goal, and because the secondary school Physics curriculum in Nigeria is learner-activity oriented, instructional strategies which are learner-centred readily come into play as appropriate tools. Learner-centered instructional strategies have numerous advantages for the learner in the teaching-learning process (Gambari and Yusuf, 2014; Josiah, 2022) as they encourage learners' interaction; equip them with skills, including communication skills; and facilitate students' achievement.

Computer-supported team-assisted individualization strategy (CTIS) is one of the learner-centred instructional strategies. Gambari and Yusuf (2013a), Gambari and Yusuf (2013b), Gambari and Yusuf (2014) viewed CTIS as a cooperative learning strategy where learners are assigned into small heterogeneous teams of three learners per team, with each learner assigned to a stand-alone computer on individualized basis to work at his/her own pace, and then work together to maximize their own and other teammates' learning goal. Each teammate works individually and cooperatively with other teammates using the computer. In other words, teammates study the same Physics concept/task independently but later move round to seek for clarification and/or assistance from other teammates; they also check each other's work on individual worksheets and help one another to understand the concept/task. Individual quiz is given to teammates but final team test is taken without help from teammates and scored by the teacher. The score obtained by an individual teammate from the individual quiz and the score from the final teamtest are summed and the average is computed as the individual's achievement in the task. Certificates or other team rewards are given to the best team in the class. This encourages cooperation in team work.

Researches such as those of Gambari and Yusuf (2015), Gambari, Yusuf and Thomas (2015) have shown that the computer-supported team-assisted individualization strategy

has significant effect on students' achievement in Physics. In Gambari and Yusuf's (2015) study, the students who were taught Physics using CTIS achieved higher than their counterparts. More research findings on computer-assisted instructional strategies showed that such strategies have significant effects on students' achievement in Physics concepts (Adolphus and Omeodu, 2020; Mankilik and Josiah, 2013; Suleman, Hussain, Din and Iqbal, 2017).

The gender factor in academic attainments has been the concern of educational researchers and administrators over the years. Josiah, Muhammad, Badewa and Zingdul (2022) recently opined that gender is an attribute which distinguishes female students from their male counterparts in terms of biological, social or traditional roles. Studies have offered varying research findings on gender achievement in Physics. Studies on the effects of computer-assisted instructional strategies such as those of Gambari and Yusuf (2015), Gambari, Yusuf and Thomas (2015), Josiah (2012), Mankilik and Josiah (2013) found no significant difference between the achievement of both male and female gender. Mankilik and Josiah's (2013) study showed that the male students taught Physics concepts had their mean achievement score only slightly higher than the female students'. Apart from gender issues in academics, school location may also play a vital role in learning outcomes.

In the context of this study, school location refers to the setting of a secondary school in either rural or urban area. Secondary schools located in rural areas are those sited in the villages or semi-urban areas while secondary schools located in urban areas are those schools in metropolitan areas. These school locations are respectively delineated in this study as rural secondary schools and urban secondary schools. Differentiating between urban and rural areas, Ezike (as cited in Nnenna and Adukwu, 2018) stated that the former is an area that is highly densely-populated, characterized by high variety and beauty while the later is an area that is less-densely populated, characterized by monotonous and burdening subsistence livelihood. Josiah (2012) opined that when students are subjected to equal opportunities in learning Physics, the location of a school will not be a significant determining factor in students' achievement. This means that the area in which a school is located does not affect the achievement of a student in Physics.

Studies have been carried out on students' achievement based on school location. In a study on the influence of school location on students' achievement in Basic Science, Awodun and Oyeniyi (2018) found out that students in urban secondary schools achieve significantly higher than those in rural secondary schools. The same finding was later obtained by Agube, Ntibi and Neji (2021) when they sought to enhance students' achievement in Physics through concept mapping instructional strategy. Studies such as those of Abamba (2021), Bizimana, Mutangana and Mwesigye (2022) and Josiah (2012) found no significant difference between the achievement of students who study in urban and rural areas, even though the studies focused on 5E learning cycle, computer-assisted instruction and concept mapping, respectively, as the strategies employed.

It was apparent that at the time of this study, studies on facilitating secondary school students' achievement in circular motion concept using computer-supported team-assisted individualization strategy (CTIS) in Mangu local government area, Nigeria were either scarce or unavailable. Mangu local government area is one of the 17 local government areas in Plateau state, Nigeria. This study was, therefore, carried out to determine the achievement of secondary school students in concept of circular motion in Physics when they are taught using CTIS in Mangu local government area, Nigeria; find out the achievement of secondary school male and female students in concept of circular motion when taught using CTIS in the locality; ascertain students' achievement in concept of circular motion in urban and rural secondary schools when taught using CTIS in the locality; determine the significant difference between the mean achievement scores of students who are exposed to concept of circular motion using CTIS and those who are exposed to it using conventional expository strategy (CES); ascertain the significant difference between the mean achievement scores of male and female students who are taught concept of circular motion using CTIS; and find out the significant difference between the mean achievement scores of students in urban and rural secondary schools who are taught concept of circular motion using CTIS.

### **Statement of the Problem**

The problem that resulted to this study was the poor and fluctuating achievement of students in Physics in Mangu local government, Nigeria. This situation needs to be addressed if the objective, provided by NERDC (2008), of inculcating the essential skills and attitudes in students preparatory to technological application of Physics is to be achieved. Lending credence to the achievement in Physics situation in Mangu local government area, Nigeria, Mankilik and Josiah (2013) stated that the persistent poor performance of students in Physics over the years in Nigeria signifies that little or no learning of concepts takes place in the students. This could be as a result of the conventional expository strategy (CES) which most Physics teachers employ in teaching concepts, and which Boyo (cited as cited in Josiah and Larina, 2015) revealed is ineffective. Josiah and Larina (2015) posited that the use of the CES by Physics teachers in secondary schools in Nigeria also contradicts the use of learner-centred instructional strategies advocated for by NERDC (2008). One way to overcome the poor and fluctuating achievement of students in Physics in Mangu local government, Nigeria, could be to adopt innovative, learner-centred instructional strategies.

It was based on the afore-mentioned that this study aimed at determining the effects of computer-supported team-assisted individualization strategy on secondary school students' achievement in Physics in Mangu local government area, Nigeria.

### **Research Questions**

The following research questions were raised for the study:

1. To what extent does the mean achievement score of senior secondary two (SS II) students who are taught concept of circular motion in Physics using computer-supported team-assisted individualization strategy (CTIS) differ from that of SS II

- students who are taught using conventional expository strategy (CES)?
2. What is the difference between the mean achievement scores of SS II male and female students who are all taught concept of circular motion in Physics using CTIS?
  3. What is the extent to which the mean achievement score of SS II students who are taught concept of circular motion in Physics using CTIS in urban secondary schools differ from that of their counterparts who are also taught using CTIS in rural secondary schools?

### **Hypotheses**

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of SS II students who are exposed to concept of circular motion in Physics using CTIS and those exposed to same concept using CES.
2. There is no significant difference between the mean achievement scores of male and female SS II students who are taught concept of circular motion in Physics using CTIS.
3. There is no significant difference between the mean achievement scores of SS II students in urban and rural secondary schools who are taught concept of circular motion in Physics using CTIS.

### **Methodology**

This study adopted the quasi-experimental research design of the non-equivalent control group pre-test, post-test type. This was due to intact classes used in the study. The target population of the study was the entire 600 senior secondary two (SS II) students (310 male students and 290 female students) who offered Physics during the 2020/2021 academic session in all the government-approved co-educational secondary schools in Mangu local government area, Nigeria. There were 352 students (192 males and 160 females) in the urban secondary schools and 248 students (152 males and 96 females) in the rural secondary schools. The reason for using SS II students for the study was due to the fact that SS I students were just being introduced to Physics and SS III students were preparing for their graduating examinations. Moreover, the topic circular motion fell within the SS II scheme of work in some secondary schools in Mangu local government area, Nigeria at the time of this study.

The sample, which was obtained using the purposive sampling technique, consisted of 66 SS II students (41 males and 25 females) from four intact co-educational secondary school classes (two from urban secondary schools and the remaining two from rural secondary schools) who offered Physics. Availability of computer facilities and same Physics scheme of work was the criteria employed to select the four schools (two urban and two rural secondary schools). The simple random sampling technique was, thereafter, used to place the intact classes from the two selected urban secondary schools into experimental group and control group. The same technique was used to place the selected rural secondary schools into the experimental and control groups. The experimental group

consisted of 34 students (19 males and 15 females) while the control group had 32 students (22 males and 10 females). In the experimental group, there were 20 students from the urban secondary schools and 14 students from the rural secondary schools. The control group consisted of 19 students from the urban secondary schools and 13 students from the rural secondary schools.

One instrument, Circular Motion Achievement Test (CMAT), was used to gather data for the study. The CMAT was a 30-item multiple-choice instrument developed by the researchers using table of specification, past Senior Secondary School Certificate Examinations (SSCE) questions of West Africa Examinations Council (WAEC), National Examinations Council (NECO) and past Unified Tertiary Matriculation Examinations (UTME) questions of Joint Admissions Matriculation Board (JAMB). The items were based on the topic 'circular motion' in SS II scheme of work. Each item consisted of four options labeled A-D, with one correct option and three incorrect options). Each correct option of an item was scored 2 points and each incorrect option had a score of 0 point. A respondent ticking all correct options of the items in the CMAT obtained a total score of 60. The total score obtained by each respondent was, thereafter, converted to percentage as achievement in circular motion concept.

The CMAT was content-validated by three experts from the University of Jos, Nigeria; and its reliability coefficient was computed as 0.90 using the Kuder-Richardson formula 20 (KR-20) method on the Statistical Packages for Social Sciences (SPSS) version 26. The treatment of CTIS was given to the experimental group for four weeks. However, a week before treatment commenced, pre-test was administered to both the experimental and control groups with the help of the research assistants in the sampled schools. This was done to ascertain the entry cognitive ability of the students. The treatment (CTIS) consisted of formulae, simulation activities and solved examples on circular motion with explanations in the computer. The control group was simply exposed to the same circular motion concept, but using the CES, during the same treatment period for the experimental group. Post-test was, thereafter, conducted the week after the treatment. The post-test was administered to find out if the CTIS facilitated the students' cognitive ability in the concept of circular motion. The statistical mean was used to answer all the research questions, while the t-test of independent samples was used to test all the null hypotheses on the SPSS version 24 at 0.05 level of significance.

## **Results**

### **Research Question One**

To what extent does the mean achievement score of senior secondary two (SS II) students who are taught concept of circular motion in Physics using computer-supported team-assisted individualization strategy (CTIS) differ from that of SS II students who are taught using conventional expository strategy (CES)?

**Table 1:** Analysis of Post-Test Mean Achievement Scores and Standard Deviations for SS II Students Exposed to CTIS and CES

Group	N	Mean	Std. Deviation
Experimental	34	81.06	8.49
Control	32	46.22	6.07

Source: SPSS Version 26.

Table 1 reveals that the post-test mean achievement scores and standard deviations of SS II students for CMAT in the experimental group were 81.06 and 8.49, respectively; while the post-test mean achievement scores and standard deviations of SS II students in the control group were 46.22 and 6.07, respectively. The result indicated that the students who were treated with CTIS achieved higher than those taught with CES. This implies that the treatment of CTIS facilitated students' achievement in the concept of circular motion in Physics.

### Research Question Two

What is the difference between the mean achievement scores of SS II male and female students who are all taught concept of circular motion in Physics using CTIS?

**Table 2:** Analysis of Post-Test Mean Achievement Scores and Standard Deviations for SS II Male and Female Students Exposed to CTIS

Gender	N	Mea	n	Std. Deviation
Male	19	81.32		8.67
Female	15	80.73		8.54

Source: SPSS Version 26.

Table 2 shows that the post-test mean achievement score and the corresponding standard deviation for SS II male students who were taught the concept of circular motion in Physics using CTIS were 81.32 and 8.67; those for their female counterparts were 80.73 and 8.54. The result showed that there was no much difference between the mean achievement scores of male and female students who were taught the concept of circular motion using CTIS. This means that the CTIS had almost equal effect on the achievement of both male and female students in concept of circular motion in Physics.

### Research Question Three

What is the extent to which the mean achievement score of SS II students who are taught concept of circular motion in Physics using CTIS in urban secondary schools differ from that of their counterparts who are also taught using CTIS in rural secondary schools?

**Table 3:** Analysis of Post-Test Mean Achievement Scores and Standard Deviations for SS II Students in Urban and Rural Secondary Schools

Location	N	Mean	Std. Deviation
Urban	20	81.06	8.49
Rural	14	64.22	3.62

Source: SPSS Version 26.

Table 3 reveals that the post-test mean achievement score and standard deviation of SS II students in urban secondary schools were 81.06 and 8.49, respectively; those for the students in rural secondary schools were 64.22 and 3.62. The result showed that the mean achievement score of students in the concept of circular motion in Physics in the urban secondary schools was higher than that of the students in the rural secondary schools.

### Hypotheses One

There is no significant difference between the mean achievement scores of SS II students who are exposed to concept of circular motion in Physics using CTIS and those exposed to same concept using CES.

**Table 4:** t-test Analysis of Post-Test Mean Achievement Scores for SS II Students Exposed to CTIS and CES

Groups	N	Mean	SD	Df	t-value	P-value	Decision
Experimental	34	81.06	8.49	64	19.081	.000	Significant
Control	32	64.22	3.62	60			

Source: SPSS Version 26.

Table 4 reveals the computed t-value of 19.081 and p-value of 0.000. Since the obtained p-value of 0.000 was less than the alpha value of 0.05, the null hypothesis was rejected. That signifies that there was a significant difference between the mean achievement scores of SS II students who were exposed to concept of circular motion in Physics using CTIS and those who were exposed to same concept using CES. The implication is that the students who were taught the concept of circular motion in Physics using CTIS achieved significantly higher than those taught using CES. This could be attributed to the effect of CTIS which facilitated the achievement of the students who were taught the concept of circular motion.

### Hypothesis Two

There is no significant difference between the mean achievement scores of male and female SS II students who are taught concept of circular motion in Physics using CTIS.

**Table 5:** t-test Analysis of Post-Test Mean Achievement Scores for SS II Male and Female Students Exposed to CTIS

Group	s	N	Mean	SD	D	Df	t-value	P-value	Decision
Male	1	9	81.3	2.86	7	32	0.196	.846	Not sig.
Female	1	5	80.7	3.85	4				

Source: SPSS Version 26.

Table 5 reveals that the computed t-value and p-value were 0.196 and 0.846, respectively. Since the obtained p-value of 0.846 was greater than the alpha value of 0.05, the researchers failed to reject the null hypothesis. This means that there was no significant difference between the mean achievement scores of male and female SS II students who were taught concept of circular motion in Physics using CTIS. The implication is that CTIS facilitated both male and female students' achievement in the concept of circular motion in Physics.

### Hypothesis Three

There is no significant difference between the mean achievement scores of SS II students in urban and rural secondary schools who were taught concept of circular motion in Physics using CTIS.

**Table 6:** t-test Analysis of Post-Test Mean Achievement Scores for SS II Students Exposed to CTIS in Urban and Rural Secondary Schools

Group	s	N	Mean	SD	D	Df	t-value	P-value	Decision
Urban	2	0	81.0	6.84	9	55	8.963	.000	Significant
Rural	1	4	64.2	2.36	2				

Source: SPSS Version 26.

Table 6 reveals that the t-value computed was 8.963 and the p-value was 0.000. Since the obtained p-value of 0.000 was less than the alpha value of 0.05, the null hypothesis was rejected. That is, there was a significant difference between the mean achievement scores of SS II students in urban and rural secondary schools who were taught concept of circular motion in Physics using CTIS. This implies that the students from urban secondary schools achieved significantly higher than their counterparts in the rural secondary schools, even though they were all taught the concept of circular motion in Physics using CTIS.

### Discussion

From Table 1, the computer-supported team-assisted individualization strategy (CTIS) enhanced students' achievement in the concept of circular motion in Physics. The students who were treated with CTIS achieved much higher in the concept than those taught with the conventional expository strategy (CES). This agrees with the finding of Gambari and Yusuf (2015) that students who are taught using CTIS score higher.

Furthermore, Table 4 shows that the difference between the mean achievement scores of the students who were exposed to the concept using CTIS and those who were exposed to same concept using CES is significant. This finding concurs with those of Gambari and Yusuf (2015), Gambari, Yusuf and Thomas (2015). This revelation could be attributed to the effect of CTIS which facilitated the achievement of the students who were taught the concept of circular motion. The educational implication is that students who are taught the concept of circular motion in Physics using CTIS will achieve significantly higher than those taught using CES.

From table 2, there was no much difference between the mean achievement scores of male and female students who were taught the concept of circular motion using CTIS. This finding is in consonance with the finding of Mankilik and Josiah (2013) that not much difference is found between the mean achievement scores of both students' gender taught Physics concepts using computer-assisted instruction. Table 5 further reveals that there is no significant difference between the mean achievement scores of male and female students who were taught the concept using CTIS. The finding is in concordance with that of Mankilik and Josiah (2013) who did not find any significant difference between the achievement of male and female students after exposure to treatment. The educational implication is that CTIS enhances students' achievement in the concept of circular motion in Physics, irrespective of the students' gender.

Table 3 shows that the mean achievement score of students in the urban secondary schools was higher than that of the students in the rural secondary schools after the students in both school locations were exposed to the concept of circular motion in Physics using CTIS. Table 6 further reveals a significant difference between the mean achievement scores of students in urban and rural secondary schools who were taught concept of circular motion in Physics using CTIS. This finding concurs with those of Agube, Ntibi and Neji (2021), Awodun and Oyeniyi (2018) that students in urban secondary schools achieve significantly higher than their counterparts in rural secondary schools. However, this is a discordant finding with those of Abamba (2021) and Josiah (2012) who found no significant difference between the achievement of students who study Physics concepts in urban and rural areas. The students from urban secondary schools achieved significantly higher than their counterparts in the rural secondary schools, even though they were all taught the concept of circular motion in Physics using CTIS. Although students in both locations were taught the concept of circular motion using CTIS, the students in rural secondary schools achieved averagely lower than their counterparts in the urban secondary schools; this is because of the possible reason that they place less value on education and are further burdened with farm work and business to assist in fending for their families.

### **Conclusion**

Computer-supported team-assisted individualization strategy (CTIS) has been found to facilitate the achievement of students in the concept of circular motion in Physics. Moreover, the strategy is not gender-biased in terms of achievement and it does not discriminate students' achievement based on their school location.

## Recommendations

Based on the findings of this study, the following recommendations were proffered:

1. Physics teachers should be encouraged to teach Physics using Computer-supported team-assisted individualization strategy (CTIS) since it has been found to facilitate students' achievement in the concept of circular motion.
2. Curriculum planners should be encouraged to incorporate CTIS in secondary school Physics curriculum since it has been found to facilitate both male and female students' achievement in the concept of circular motion in Physics.

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