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Information and communication technology tool and children's achievement in Basic Science: Implication for Evaluation of Library and Information Resources

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Abstract

The mode of teaching shifted from the traditional face-to-face to the remote or online mode of teaching in most countries of the world due to the emergence of coronavirus disease 2019 (COVID-19). Thus, the new normal demands the use of information and communication tool for instructional delivery across the levels of education. On this premise, the study sought the efficacy of information and communication tool (flipped classroom) on the children's achievement in Basic Science. Adopting simple repeated measures design, 31 primary three children participated in the treatment session. Basic Science Achievement Test (BSAT) that was properly validated and trial-tested was used to collect data for the study. The children were exposed to two different pretests prior to the treatment and two posttests after the treatment. A mixed-design repeated-measures analysis of variance was used to analyse the data. The finding revealed that information and communication technology tool (flipped classroom) significantly ($p = 000$) improved the achievement of children in Basic Science. This finding implicates evaluation of library and information resources to come up with best practices in online information resources to propere instructional delivery. Based on this finding, the adoption of information and communication technology (flipped classroom) in teaching and learning Basic Science was recommended.

Keywords: Basic science, Children, Information and communication technology, Library and information resources

Introduction

There have been reports over the years of low achievement of children in Basic Science which is the foundation of science subjects at upper education levels (Ugwuanyi, et al., 2020; Agboeze et al., 2020). Teachers' use of traditional methods of teaching has been

implicated for such poor performance of children in the subject. With the emergence of coronavirus disease 2019 (COVID-19), the mode of teaching shifted from the traditional face-to-face to the remote or online mode of teaching in most countries of the world. The emergence of coronavirus disease in 2019 (COVID-19) has brought drastic changes in the educational system across the globe. This has caused many schools especially in the developed country to adopt the online mode of teaching as a face-to-face mode of teaching was kept on hold to avoid the spread of COVID-19. However, there is evidence of most classrooms across the globe been dominated by lectures and text-based learning (Chang & Lan, 2021).

According to Jia et al. (2020), the abrupt change as a result of COVID-19 has led to a general fear of a drop in the quality of education as a result of lack of physical interaction. Among the online educational approaches, information and communication technology tool (flipped classroom) has received significant popularity in recent years (Ekici, 2021). Flipped classroom instructional approach reverses the traditional teaching method by asking students to do assignments or homework outside of the classroom through online media (Series, 2021). According to Chang and Lan (2021), there is well-documented evidence of the effectiveness of the flipped classroom approach across disciplines in both K-12 and higher education. The flipped classroom is a well-known teaching strategy for many science courses in most countries (Doğan et al., 2021). The flipped classroom in a nutshell is the inversion of conventional classroom procedures (Doğan et al., 2021). The flipped classroom is a student-centered learning approach that involves allowing the learners to complete pre-class work to obtain basic knowledge before the actual classroom activities (Lichvar et al., 2016). In flipped classroom, pre-class activities comprise textbook, web-based, or literature readings or watching of videos of classroom lessons at a pace suitable to their own learning needs (Lichvar et al., 2016). Flipped learning as an innovative active learning approach provides

students with several opportunities (Birgili et al., 2021). A lot of recent studies have been carried out on the effectiveness of flipped classroom on learners' achievement in different subject areas especially sciences.

The use of information and communication technology tool (flipped classroom) improved the performance of students in the English language (Chang & Lan, 2021). There was a significant positive effect of the implementation of flipped classroom approach on academic achievement in Science classes (Doğan et al., 2021). Lichvar et al. (2016) revealed that the use of flipped classroom is an effective and active learning strategy in a population of high school students. The use of flipped classroom approach significantly improved the interest of students in the learning of modules than those taught using the traditional teaching approach (Rotellar & Cain, 2016) (Afzali & Izadpanah, 2021). Adding game elements into a flipped classroom had a significant effect on the students' better-learning performance, motivation, and participation (Ekici, 2021). Teachers' use of flipped classroom significantly improved students' academic achievement compared with the other classroom models (Polat & Karabatak, 2021).

Furthermore, students who were exposed to flipped courses significantly exhibited gains in critical thinking than their counterparts who were not so exposed (Styers et al., 2018). In a sample of science students, flipped classroom significantly had an effect on the performance of the students better than their counterparts taught using the traditional lecture method (Joseph et al., 2021). Students' performance significantly improved as a result of the outcomes of flipped learning (Birgili et al., 2021). Flipped classroom approach significantly enhanced the students' performance and perceptions of an online open distance-learning environment (Van Wyk, 2019). Adonu et al. (2021) found that students exposed to flipped classroom instructional approach significantly improved in their achievement in Biology after the exposure.

The foregoing has ex-rayed the quality of research done on the effectiveness of flipped classroom approach on students learning outcomes. The different empirical evidence from the above research have proved the effectiveness of flipped classroom approach. However, most of those studies centered on high school and university students rather than the primary school children/pupils. Moreover, none of the reviewed studies was carried out in Nigeria. Thus, these gaps in literature necessitated this empirical research on the use of flipped classroom at the primary school level in the Nigerian context. This research aimed to explore the effectiveness of flipped classroom instructional approach on children's achievement in Basic Science in Nigeria. The researchers hypothesized that flipped classroom instructional approach had a significant ($p < .05$) effect on children's achievement in Basic Science.

Methodology

Research design

This study adopted a simple repeated measures research design. This design involves the use of a single group of participants who are normally exposed to different test occasions before the commencement of the treatment and then subjected to different test occasions after the treatment. In this case, the different test occasions serve as the control to the treatment condition. This design has been used recently by (Ugwuanyi, Gana, et al., 2020; Onyishi et al., 2021) in similar studies.

Participants

A sample of 31 primary three pupils participated in this study. The participants were sampled from a population of primary three children in primary schools in Enugu state Nigeria. A purposive sampling technique was used to select children who have access to home technology such as computers and smartphones with internet facilities.

Measure

The Basic Science Achievement Test (BSAT) developed by the researchers was used for data collection. BSAT is a 30-item multiple-choice test with options A, B, C, and D of which the children were expected to select the correct option for each of the questions. The items of the BSAT were generated from the primary three basic science scheme of work or curriculum. Any correct answer to a question attracted 2 marks implying minimum and maximum scores of 0 and 60 respectively.

Validation and reliability of the measure

The BSAT was faced validated by test development experts in the researchers' institutions. The experts were requested to facially look at the items of the BSAT concerning the wording of the items, suitability of the items to the research purpose, quality of the items, language used. After their validation verdicts, the BSAT was modified accordingly. Besides, the content validation of the BSAT was ensured using a Table of specifications which was also vetted by the experts. Thereafter, copies of the BSAT were administered to the equivalent group of children in a different location to ascertain the reliability of the items of BSAT. The data obtained from such administration were analysed using Kuder-Richardson formula 20 which yielded an internal consistency reliability index of 0.84. The estimate of the temporal stability of the BSAT was also determined by administering the copies of it at two weeks interval of the first administration. The data obtained in the two administrations were analysed using Pearson correlation which gave an index of 0.88.

Procedure

The researchers visited the schools used for the research to obtain written permission from the school headteachers before the commencement of the research. The children who participated in the research were also served with informed consent forms to fill and sign as a

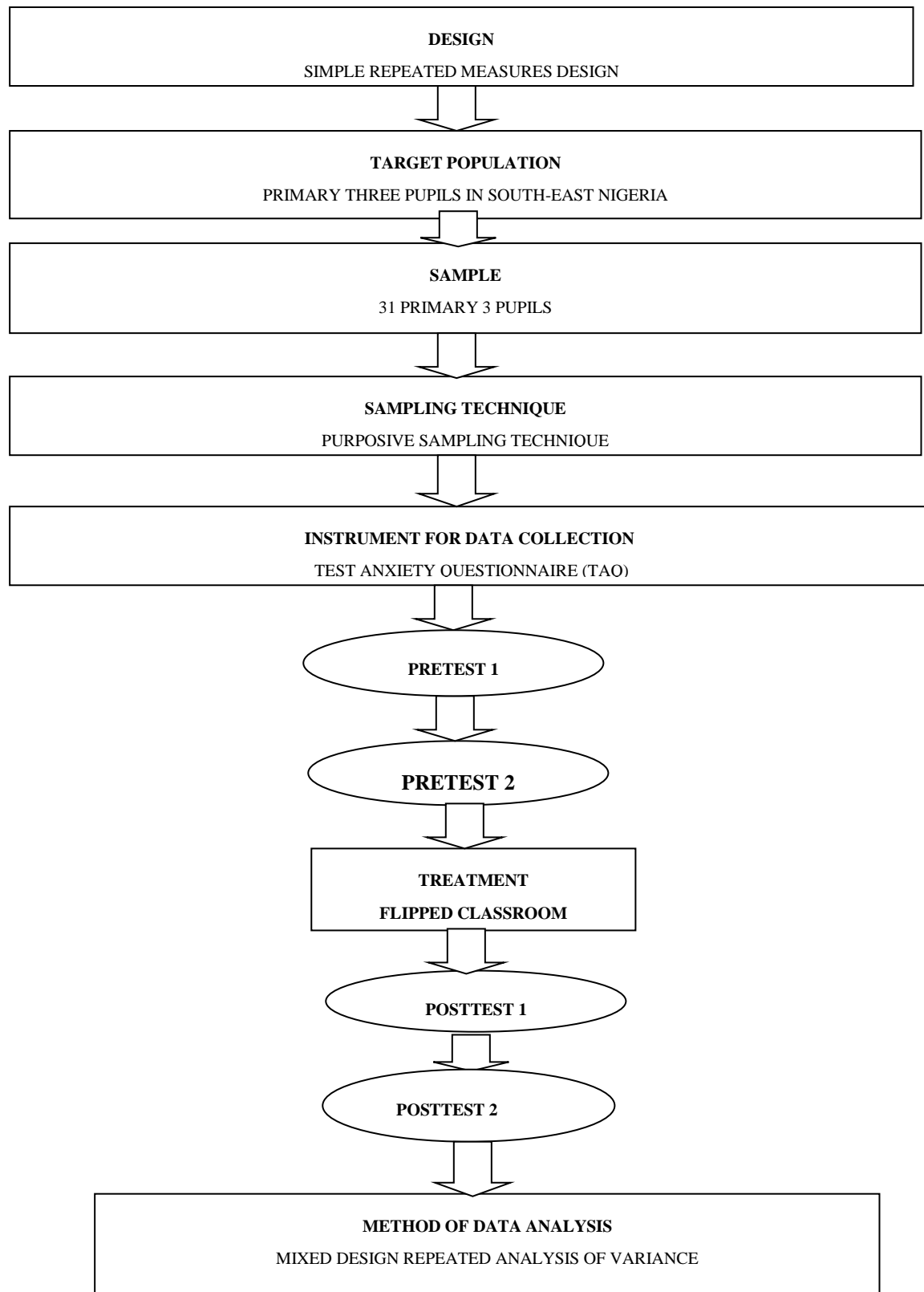
mark of their willingness to participate. Having done all those, the researchers scheduled for baseline assessments on two different occasions. Thus, the participants were given the items of BSAT to respond to on two different occasions before the actual treatment started. On each of the occasions, the children were allowed to respond to the items of BSAT in a space of 40 minutes. Thereafter, the treatment commenced. The participants were exposed to a 6-week treatment condition using flipped classroom instructional approach. The contents of Basic science the participants were exposed are concepts of matter, work, energy, power, and electricity. The participants were provided online materials on those concepts to study at home through an online platform and thereafter shared their experiences in the real classroom with the teacher as a moderator. This exercise lasted for 6 weeks after which posttests were administered to the participants on two different occasions.

Ethical approval statement

The ethical approval for the conduct of this research was granted by the University of Nigerian committee on research ethics.

Data analysis

Data collected from the four different test occasions were analysed using mixed-design repeated measures analysis of variance. Mauchly's test of sphericity for the assumption of the sphericity of repeated measures ANOVA was not significant (Mauchly $W = .859$, $p = .502$).

Figure 1: Schematic Representation of the Methodology

Results

Table 1: Participants demographic characteristics

Demographics characteristics		n (%)	χ^2	<i>p</i>
Gender	Male	13(41.94)	11.09	<.050
	Female	18(58.06)		
Age	6-7 Yrs	19(61.29)	18.23	< .050
	8-9 Yrs	8(25.81)		
	>9 Yrs	4(12.90)		
Location	Urban	20(64.52)	10.98	<.050
	Rural	11(35.48)		

Table 1 revealed that there are significant differences in the demographic characteristics of the participants, $\chi^2 = 11.09$, $p < .050$ (participants' gender); $\chi^2 = 18.23$, $p < .050$ (age of participants); $\chi^2 = 10.98$, $p < .050$ (location of participants).

Table 2: Mean analysis of the achievement scores of the participants at four different test occasions

Test occasion	n	Mean	Std. Deviation
Pretest 1	31	10.96	1.30
Pretest 2	31	11.09	1.85
Posttest 1	31	48.12	4.48
Posttest 2	31	48.58	4.41

Table 2 shows that at pretests 1 and 2, the participants had mean achievement scores of ($M = 10.96$, $SD = 1.30$ and $M = 11.09$, $SD = 1.85$) while at posttests 1 and 2, the participants had mean achievement scores of ($M = 48.12$, $SD = 4.48$ and $M = 48.58$, $SD = 4.41$).

Table 3: Repeated measures analysis of variance of the difference in the test occasions

Source		Type III Sum			F	Sig.	Partial Eta Squared
		of Squares	df	Mean Square			
Time	Sphericity Assumed	43185.645	3	14395.215	1672.016	.000	.982
	Greenhouse-Geisser	43185.645	1.416	30496.522	1672.016	.000	.982
	Huynh-Feldt	43185.645	1.466	29461.951	1672.016	.000	.982
	Lower-bound	43185.645	1.000	43185.645	1672.016	.000	.982
Error(Time)	Sphericity Assumed	774.855	90	8.609			
	Greenhouse-Geisser	774.855	42.483	18.239			
	Huynh-Feldt	774.855	43.974	17.621			
	Lower-bound	774.855	30.000	25.828			

Table 3 revealed that flipped classroom had a significant effect on the development of sound knowledge of Basic Science, $F(3, 90) = 1672.016$, $p < .05$, $\eta_p^2 = .982$. Thus, the effect size of .982 indicates that 98.2% change in the children's knowledge of Basic Science is attributed to the effect of the flipped classroom. The post hoc pairwise comparison for the significant difference in the mean scores of the participants at different test occasions is shown in Table 4. Table 4 showed that the mean difference between test 4 and test 1 contributed most to the significant difference followed by the mean difference between test 4 and test 2.

Table 4: Post-Hoc pairwise comparison test for the significant difference in the test occasions

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	-.226	.285	.967	-1.028	.576
	3	-20.194*	1.427	.000	-24.211	-16.176
	4	-22.323*	.915	.000	-24.900	-19.746
2	1	.226	.285	.967	-.576	1.028
	3	-19.968*	1.398	.000	-23.904	-16.032
	4	-22.097*	.888	.000	-24.596	-19.597
3	1	20.194*	1.427	.000	16.176	24.211
	2	19.968*	1.398	.000	16.032	23.904
	4	-2.129	.856	.107	-4.540	.282
4	1	22.323*	.915	.000	19.746	24.900
	2	22.097*	.888	.000	19.597	24.596
	3	2.129	.856	.107	-.282	4.540

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Sidak.

Analysis of possible moderators

Table 5: Process analysis of the influence of the moderators

Model	coeff	se	t	p	LLCI	ULCI
constant	-11.1545	12.5301	-.8902	.3818	-36.9617	14.6526
Posttest	1.1813	.2259	5.2281	.0000	.7159	1.6466
Gender	8.1262	6.2576	1.2986	.2059	-4.7621	21.0144
Age	-3.7184	4.0879	-.9096	.3717	-12.1379	4.7012
Location	-6.4289	6.2297	-1.0320	.3120	-19.2597	6.4019

Table 5 showed that the moderators (gender, age and location of participants) had no significant influence on the effect of flipped classroom on the development of sound knowledge of Basic Science concepts by children, $t = 1.2989$, $p = .2059$; $t = -.9096$, $p = .3717$, and $t = -.9096$, $p = .3120$.

Discussion

This study sought to determine the effect of the flipped classroom on the development of sound knowledge of Basics Science concepts by children. The findings of the study revealed that the children' development of sound knowledge of Basic Science concepts improved significantly over time as result of their exposure to flipped classroom instructional approach. This indicated that flipped classroom significantly improved the achievement of pupils in Basic Science. The finding further revealed that the effect of the flipped classroom instructional approach was not influenced by the demographic characteristics (gender, age and location) of the participants. This result goes to show that the interactive nature of flipped classroom captivates the interest of the learners vis-à-vis their achievement in such engagement. A flipped classroom is a learner-centered approach to teaching in which learners are given materials to read or watch through an online platform unlike the traditional method of teaching where the teacher does everything. In flipped classroom, pre-class activities comprise textbook, web-based, or literature readings or watching of videos of classroom lessons at a pace suitable to their own learning needs (Lichvar et al., 2016). Flipped learning

as an innovative active learning approach provides students with several opportunities (Birgili et al., 2021). Several recent empirical studies have attested to the results of this research.

Teachers' use of flipped classroom significantly improved students' academic achievement compared with the other classroom models (Polat & Karabatak, 2021). Flipped classroom approach significantly enhanced the students' performance and perceptions of an online open distance-learning environment (Van Wyk, 2019). In a sample of science students, flipped classroom significantly had an effect on the performance of the students better than their counterparts taught using the traditional lecture method (Joseph et al., 2021). Students' performance significantly improved as a result of the outcomes of flipped learning (Birgili et al., 2021). Students who were exposed to flipped courses significantly exhibited gains in critical thinking than their counterparts who were not so exposed (Styers et al., 2018). Adding game elements into a flipped classroom had a significant effect on the students' better learning performance, motivation, and participation (Ekici, 2021). The use of flipped classroom approach improved the performance of students in the English language (Chang & Lan, 2021). There was a significant positive effect of the implementation of flipped classroom approach on academic achievement in Science classes (Doğan et al., 2021). (Lichvar et al., 2016) revealed that the use of flipped classroom is an effective and active learning strategy in a population of high school students.

This result has several implications for the teaching of science subjects. It has been verified that flipped classroom instructional approach enhances pupils' achievement in the Nigerian context. This implies that science teaching in the Nigerian context will greatly improve if teachers adopt the use of flipped classroom instructional approach to teaching. Also, pupils' interest and motivation in the learning of science can be enhanced when pupils are exposed to the use of flipped classroom approach.

Implication for Evaluation of Library and information Resources

The finding of the present research implicates evaluation of library and information resources. At this era of information technology, the school libraries are no longer the only source of information since learners can access materials online. Thus, there other learning spaces such as the internet in which the learners can connect for the purpose of information gathering. There is the need for mixture of varieties of learning spaces and work environments that can accommodate different uses and possess different ambiances. Thus, the Library and Information resources are facilitated in a multi-modal resource area which is centrally located to provide equitable and ease of access by all learners. These learning spaces help learners to work in both electronic and non-electronic means, formal and informal modes of learning. The foregoing therefore, imply the need for proper evaluation of the library and information resources in order to present and store more library resources through the flipped classroom channel for easy of access by the learners.

Conclusion

Flipped classroom approach is an effective instructional approach to the teaching of Basic Science at the primary school level. It is, therefore, concluded that the use of flipped classroom instructional approach will significantly enhance the achievement of pupils in Basic Science. It is thus, recommended that teachers of Basic Science should adopt the use of flipped classroom instructional approach, especially in the COVID-19 pandemic era. Also, adequate workshops/seminars should be organised by the Local Government Education Authority to enable teachers to acquire the requisite skills in the use of the flipped classroom.

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