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ACHIEVING QUALITY PHYSICS EDUCATION FOR SUSTAINABLE DEVELOPMENT THROUGH FLIPPED CLASSROOM ENGAGEMENT

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ABSTRACT

The study investigated how Active learning Instructional strategy (flipped classroom engagement) can enhance quality physics education at the secondary school level for sustainable development. The study is a quasi-experimental design with 248 physics students of intact classes from the four schools purposively selected out of the 26 government secondary schools in the two local governments in Lagos state Nigeria. Validated physics achievement test (r=0.87) and Study habit inventory (r=0.95) were used in testing three hypotheses. Data collected were analysed using inferential statistics; Analysis of Covariance (ANCOVA). The results obtained showed that students exposed to flipped classroom engagement groups performed better than students in the conventional pen-and-talk classroom instruction group. Also, students in flipped classroom engagement group have good study habit and they performed excellently well to the students in the pen-and-talk group. Researchers, therefore, recommended the use of flipped classroom engagement for the teaching of physics at the secondary school level as a means of achieving quality physics education for sustainable development.

1. Introduction

There are variations in the definition of sustainable development. The International Institute of Sustainable Development (IISD) Brundtland Report (2022) defines sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs". However, from the available literature searches, sustainable development can be viewed as an organising principle of meeting the economic, social, and environmental protection needs of man in both the present and future generations**.** The United Nations Sustainable Development Summit in September 2015 in New York adopted the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs) that all countries of the world must focus on and develop strategies for achieving the goals. The number 4 of the SDGs is based on quality education. Hence, strategies must be developed in achieving quality education for sustainable development. In line with the above assertion, is the submission of Malavoloneque and Costa (2022) who identified education as a key element to address Sustainable development goals in general and physics education in specific. The researchers observed that physics education in Angolan schools is characterised by traditional practices and therefore recommended the professional development of physics teachers with collaborative processes to support and sustain new practices. The problem of the traditional mode of instruction in physics education is also predominant in Nigerian schools. Adolphus, Ekineh and Aderonmu (2021) reported that the teaching of physics in Nigerian schools is a teacher-centred

approach. This approach does not bring excellent performance in physics. Also, Isa, Mammam, Badar, and Bala (2020) reiterated that the teaching methods used by teachers determine the extent of student's academic performance (knowledge and skills) which is a strong factor in achieving quality education. To this end, Bawan and Udo (2019) reported that innovative method of instruction improves students' achievement in physics. Also, Ntibi and Ekpenyong (2020) reported that students taught with a self-directed learning instructional strategy performed better than those taught with the conventional method of instruction in mathematics and physics. Hence, there is a need for a pedagogical shift or a paradigm shift in physics classroom instruction to achieve quality physics education for sustainable development.

Students' classroom activities are a strong determinant of the attainment of the lesson objectives, and these accounted for the overall performance of students in physics. Also, research reports have shown that students taking ownership of classroom activities bring about excellent learning outcomes and improve performance in physics. It is therefore highly necessary to adopt active instructional strategies that will enhance the achievement of quality physics education at the secondary school level (the foundation level for physics education in Nigeria) for sustainable development.

The global world of today is that of digitalization as digital natives adopt the use of emerging technologies such as Facebook, WhatsApp, YouTube, Twitter, etc. on a daily basis to communicate, socialize, and form friendships. As evidence of this new era, Abraham and Onyema (2020) advocated for a teaching strategy that integrates a blend of technologies for students' better academic performance. This instructional strategy is blended learning. This form of learning is an application of Information Technology and Communication (ICT) into education (Dakhi & Ifran, 2020). Alsalhi, Al-Qatawneh, Eltahir and Agel (2019) see blended learning as a strategy that combines the face-to-face method of instruction with e-learning. The researchers added that blended learning has a positive impact on student's achievement in physics and in the development of skills. Also, Asif and Shehzad (2019), Hrastinski (2019), and Krasnova and Shurygin (2019) reported that blended learning fosters effective interaction between teachers and students. Also, Hadiyanto (2020) report that students are supportive of activities delivered by blended learning. There are different forms of blended learning. One such form is flipped classroom engagement which is an active learning strategy.

A flipped classroom engagement, according to Jordan (2021), is a form of blended learning that converts the face-to-face traditional method of in-class lectures to short videos to be watched outside of class and uses classroom time for interactive activities, guided problem-solving, and discussion. Also, White, Naidu, Yuriev, Short, McLaughlin and Larso (2017) see the flipped classroom as an approach that engages students with pre-activities that prepare them for in-class active learning. The flipped classroom engagement allows students to learn at their pace, develop the right attitude to learning, and increase students' commitment to learning (Ozkal, 2019; Sun & Wu, 2016). Avery et al (2018) reported that flipped classrooms develop confidence and a growth mindset. While Irvine (2020) reported that the strategy improves the interaction between teachers and students. Abu-Hilai and Al-Abed (2019) therefore suggested that teachers must equip students with appropriate skills for the strategy to be effective. Research reports by Fouche (2017) as well as Oriogu and Subair (2017) reported that most research on flipped classroom instructions is foreign and that study habit is one of the variables that influence the achievement of students while the reports of Alva (2017) Azzopardi and Camilleri (2018) indicate no influence of study habit on achievement of students.

A review of related literature on flipped instructional strategy showed its efficacy over the traditional method of instruction; Thai et al (2017) and. Casasola et al (2019) found that students in the flipped classroom performed significantly better than those in the control group. Also, Siguroardottir and Heijstra (2020) reported that flipped classroom engagement allowed the use of technology in the physics curriculum and it involves different activities. Avery et al. (2018) argued that it allowed students to learn at their own pace and be more responsible for their own learning with some students classifying this as a "sink or swim" type of learning style. Meremikwu, and Ibok. (2020) reported that the mode of instruction influences the performance of students in mathematics class and science in general. Still along this direction, Sun, and Wu (2016) reported that flipped engagement produced higher academic performance in physics. While Miles and Foggett (2016) reported that students in flipped classroom engagement prefer teaching themselves the content of the lesson rather than learning them from the teacher. Hodgson et al (2017) reported that students who participated in flipped engagement said the video section changed their conception of their teacher and the strategy increased interaction between teacher and students hence, increased academic performance.

Engagement is the act of students participating in their learning and being actively involved and curious about the topics of the lesson (Abu-Hilai & Alabed, 2019; Avery et al., 2018; Irvine, 2019; Ozkal, 2019; Poysa et al., 2019). The pre-recorded video and the in-class activities are used to engage the students. Literature showed there are three types of engagements according to Ozkal (2019) namely: behavioural engagement which involves attending and participating in classroom activities. Affective/ emotional engagement involves a willingness to be involved in classroom activities and cognitive engagement entails making cognitive efforts towards learning the material in the activities and being willing to advance that knowledge.

Study habits are a moderator variable in this study. Research reports show that the variable has a great influence on the performance of students. The study of Rabia, Mubarak, Tallat and Nasir (2017) showed a significant relationship between study habits and the academic performance of the students. The change in students' learning environments and having to adjust to new study habits, interactions, and responsibilities of their own learning can have a positive impact on their academic performance as reported by Alsancak-Sirakaya and Ozdemir (2018). Also, the study by Bouilheres et al. (2020) reported that flipped classroom engagements changed students' study habits. Another study conducted by Okado, Kida and Sakai (2018) entitled "Changes in Study Habits of Chinese Adolescents and Factors Supporting These Habits-Focusing on the Transition Period from Elementary School to Junior High School". The result showed a high correlation between the study habit of the students and academic results. It is against the background that the study investigated the efficacy of flipped classroom engagement on the performance of students in physics and the moderating effects of study habits on the dependent variable. The strategy that proved superior will be recommended for achieving quality physics education for sustainable development.

2. Statement of the Problem

The major objective of teaching physics at the secondary school level is to produce students with excellent performance in the subject for national development. However, quality education has been identified as one of the strategies for achieving sustainable development. Physics education is an important aspect of education. Therefore, efforts must be put forward towards achieving quality physics education for sustainable development.

Instructional strategy has equally been identified as one of the determinants of learning outcomes in science in general and physics in particular. Reports of Adolphus, Ekineh and Aderonmu (2021 also show that the teaching of the subject is dominated by a teacher-centred method which has not produced excellent performance in the subject and the performance of students in the subjects has been fluctuating from 50% and slightly above 50%. (Onudibia, Okorie & Iseah,2023; Assem et al 2023& Coffies et al, 2023) There is therefore the need to search for instructional strategies for excellent performance in achieving quality physics education for sustainable development. Research reports have identified blended instructional strategies as a solution to the excellent performance of students in physics and mathematics in countries outside Nigeria. The Flipped classroom engagement is an aspect of the blended instructional strategy. This study, therefore, investigated the impact of flipped classroom engagement on the performance of students in physics at the secondary school level and the moderating effect of study habits as a means of achieving quality physics education for sustainable development.

3. Objectives of the Study

The main objective of the study is to identify the instructional strategy that will improve the performance of students in physics as a means of achieving quality physics education for sustainable development. The other objectives are to:(1) Find the main effect of study habit on the performance of students in physics as means of achieving quality education for sustainable development, and (2) determine the moderating effect of study habit on the performance of students in physics as means of achieving quality physics education for sustainable development. To achieve the above objectives, the study investigated the impacts of Flipped classroom engagement and pen-and-talk on the performance of the sampled students.

4. Research Hypotheses

$H_0$1.There is no significant main effect of Flipped classroom engagement on the performance of students in physics as means of achieving quality physics education for sustainable development.

$H_0$2: There is no significant main effect of study habits on the performance of students in physics as means of achieving quality physics education for sustainable development.Í

$H_0$3: There is no significant interaction effect of flipped classroom engagement and study habits on the performance of students in physics as means of achieving quality physics education for sustainable development.

5. Theoretical Framework

This study is based on the cognitive theory of multimedia learning of Mayer (2009) and the modified version of Bloom's Taxonomy (Kelly,2019). The cognitive theory of multimedia learning explains that students participating in the flipped classroom learn the content more effectively than those participating in the traditional model of instruction. The first step is to understand how the brain processes information (McGraw, 2019). The brain takes in information and processes it in multiple channels, based on how that information is presented. The first channel is for visually represented material and the second is for auditory represented material. When a learner is presented with visual pieces of information from a video, all go into the visual channel and are processed there. Auditory information from words and sounds is processed by the brain separately from the visual and gets logged in their sensory memory. The learner begins to work with the information to process it and learn. This happens in the working memory.

In working memory, the learner can choose relevant images and words to remember and work with. Each of these sets of information is processed and organized into two models that help the reader understand and remember. Finally, the learner integrates the visual model and the auditory model together with their prior knowledge and experiences to form new knowledge which then can move into long-term memory. Multimedia instruction helps students learn more deeply because it takes advantage of these two separate channels and allows the student to go through the process of making multiple models to really understand the material that is presented to them.

The theoretical framework of Bloom's taxonomy starts with students' activities in lower order to higher order (remembering, understanding, applying, analyzing, evaluating and creating) which takes place outside the classroom in a digital environment (watching videos in U-tube; a form of multimedia learning and its followed by students activities in higher order inside the classroom where students work on activities and assignments with the teacher and/or their peers in a constructivist environment. Looking at the flipped classroom through the lens of Bloom's taxonomy (Weitzenkamp, 2013), lower-order thinking is conducted outside the classroom and higher-order thinking is fostered inside the classroom.

6. Methodology

The study involved a pretest, posttest non–equivalent control group quasi-experimental design. It also involved one experimental (flipped classroom engagement) and one control group (traditional teaching method of pen and talk of intact classes. The population of this study consisted of all secondary school physics students in Ajeromi-Ifelodun Local Government and Somolu Local Government Areas of Lagos State. Purposive sampling was used to select the ten schools that met the criteria out of twenty-eight schools in both local governments. and the following criteria: (i) the school must be a public co-education(ii). must have a qualified physics teacher, (iii) students must have access to smartphones since flipped engagement strategy requires both online and face-to-face interaction, (iv) schools must be widely separated from each other to avoid the "interaction effect" and (iv) the readiness to participate in the study.. Four schools were randomly selected from the ten schools that met the above criteria. Thereafter, two (2) schools each were randomly assigned to flipped engagement group (group 1) and a pen and talk group (Group 2). A total of two hundred and forty-eight (248) senior secondary school physics student's year two comprising 165 males and 83 females constituted the two groups.

7. Research Instrument

Two instruments were used in collecting data in the study: a physics achievement test (PAT) and a study habit inventory (SHI). The PAT measured the performance of the students in physics. The physics achievement test consists of fifty (50) multiple-choice objective test items with a key (answer) and three distracters. The questions were developed from the course content, lesson notes, and WAEC Past Questions. It was used by the researchers to measure students' cognitive performance in physics. The content of the items covered topics like; Equilibrium of Forces (EF), Simple Harmonic Motion (SHM), Machines (M), Heat and Temperature (HT) and calculations on Specific Heat Capacity (SHC). The WAEC Chief Examiner's Report of 2016 - 2020 showed that these are the major areas in physics students' performance have been unsatisfactory. These questions were structured along; (i) the ability to recall what they have learnt and (ii) the ability to apply what they have learnt to solve problems. The administration of the physics achievement test lasted for 60 minutes (1 hour). The test item specification is shown in Table 1 below.

Table1: Physics Achievement Test (PAT) Item Specification

Content Level of Objective	EF	SHM	M	HT	SHC	TOTAL
Knowledge	5	4	3	2	1	15
Comprehension	5	2	3	2	1	13
Application	2	2	3	2	2	11
Analysis	2	2	3	2	2	11
Synthesis	-	-	-	-	-	-
Evaluation	-	-	-	-	-	-
Total	14	10	12	8	6	50

The study habit inventory used (SHI) was developed by Bakare in 1977 to measure students' study habits. It consisted of two sections (A & B) Section A consisted of (a) name of school, (b) age bracket, and (c) gender. The second section sought information based on their study habit.

SHI is made up of 45 items that cover eight (8) areas of study (namely - "homework and assignment", time allocation", "reading and note-taking", "study period procedures", "concentration", "written work", "examinations", and "teacher consultation") using on a five-point scale. It was administered to the participants in their various schools just before taking the pre-test. The information collected about respondents are.

7.1 Validation Procedure

PAT initially consisted of seventy items and was subjected to face and content validation. This was further pilot tested in a neutral senior secondary school to ensure the empirical validity of the instrument. During this process, only fifty items survived and the remaining twenty items whose reliability coefficient value (r) was low were removed. The reliability coefficient of the survived 50 items was calculated to be 0.87 using the Kuder-Richardson 20 (KR 20) formula with an average difficulty index of 0.67 and a discriminating index of 0.86.

7.2 Study Habit Inventory (SHI)

The discriminating index of the Study Habit Inventory's manual by Bakare has a test-retest reliability level of 0.83 for a group of 58 students (N = 30 boys, 28 girls) with a time interval of 3 weeks. For the purpose of this study, it was revalidated and a test re-test reliability of 0.95 and a Cronbach alpha value of 0.81. were obtained. Moreover, the instrument was slightly modified.

7.3 Scoring

PAT was scored with 1 mark for each correct answer.

The SHI was scored using the scoring key; "Almost never", "Less than half of the time", "About half of the time", "More than half of the time", and "Almost always" attracted a value of 5, 4, 3, 2, and 1 respectively, for the positive items and the reverse for negative items. In the end, the scores of each student were summed up. The highest score obtainable in the inventory is 225 while the lowest is 45. A score of 135 and above was classified as good study habit and poor study habit for scores below 135.

7.4 Procedure for Data Collection:

The study lasted for the period of eight weeks (2 months) with the following procedural steps:

Week 1-2: Training of research assistants in all four schools.

Week 3: Administration of SHI and PAT as pre-test on both the experimental and control groups.

Week 4-7: Administration of flipped engagement and Pen and talk instructional strategies.

Week 7-8: Revision and administration of Post-test performance.

7.5 Instructional Procedural Steps of the Treatments:

1. **Flipped Classroom Engagement group)**

Phase 1. Pre-School Time (Online Instruction): This phase takes place prior to the physical classroom session (face-to-face instruction). It involves the sharing of online resources on the lesson such as videos, and audio recordings, via a social media platform (WhatsApp). Here, the learners are required to visit the WhatsApp group page created for this purpose to access (download materials) the online materials and study, watch and/or listen to them prior to the in-person class time.

Phase 2a. In-Class Time/Face-to-Face Instruction: This is the physical classroom session or in-person class time that is the face-to-face instruction where the students attend a physical class at a "brick and mortar" location. This stage is divided into three (3) segments which include grouping, discussion, and presentation.

1. Grouping:

This segment involves dividing the class into groups. The learners are allowed to watch the videos again together in groups and take notes for them to interact and consolidate.

2. Discussion:

Here, the learners are given the opportunity to discuss, interact and consolidate on what they have learnt from the lesson. This helps the learners leverage their understanding of one another and make corrections where necessary.

3. Presentation:

Here, each member of the group is allowed to do a few minutes presentation of a particular aspect of the topic which would entail a summary of their group discussions on that aspect of the topic.

At the end of each presentation, questions are taken from other group members and will be answered by the presenter or his/her group members.

Phase 3. Question and Answer Phase (In-Class Time): In this stage, areas that have not been fully addressed during the groups' presentations or other challenging concepts are addressed by the facilitator (the physics teacher) and ultimately summarizes the lesson.

Control Group (Pen and Talk Method).

Step 1. The teacher introduces the lesson.
Step 2. The teacher explains the concept in each lesson.
Step 3. The teacher gives examples and solves numerical problems.
Step 4. The teacher asks questions and allows students to ask questions.
Step 5. The teacher gives classwork to students.
Step 6. The teacher marks students' work and gives feedback to students.

The data collected was collated and inputted into SPSS version 21, and inferential statistics (ANCOVA) was used to test the stated hypotheses.

8. Results

Ho1: There is no significant main effect of treatment (flipped classroom and Pen and talk methods) on students' performance in physics.

Table 2: Summary of Analysis of Covariance of Students' performance by Treatment, and Study habit

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	36802.044[a]	5	4600.255	542.860	.000
Intercept	274.936	1	274.936	32.444	.000
TREATMENT	262.899	1	262.899	31.024	.000*
STUDYHABIT	56.203	1	56.203	151.632	.011*
PRETEST	26.359	1	26.359	45.110	.079
TREATMENT * STUDYHABIT	42.141	1	42.141	245.973	.027*
Error	2025.311	239	8.474		
Total	257966.000	248			
Corrected Total	38827.355	247			

[a.] R Squared = .948 (Adjusted R Squared = .946) * Significant at p <0.05

Table 2 shows that $F_{(1,247)} = 31.024$ is statistically significant at a 0.05 level of significance. This implies that there was a significant main effect of treatment on the student's achievement in physics at P<0.05 level of significance. Thus, $H_0 1$ was rejected.

Variables	Estimated Mean	Standard deviation	n
Flipped Engagement	36.005	1.250	115
Pen and Talk	26.006	2.500	133
Total		248	

Table 3 showed the estimated mean of students in the flipped engagement group =36.005 and students in the pen and talk group = 26.006. Hence, students in the flipped engagement group performed better than students in the pen-and-talk group.

H02: There is no significant main effect of study habits on students' performance in physics.

Table 2 indicated that $F_{(1,247)} = 151.632$ is statistically significant at a 0.05 level of significance. This implies that there was a significant main effect of study habits on the student's achievement in physics at P<0.05 level of significance. Thus, reject Ho2.

Ho3: There is no significant interaction effect of treatments and study habits on students' performance in physics.

Table 2 indicated that ($F_{(1,247)} = 245.973$, p=0.027) is statistically significant at 0.05 level of significance. This implies that there was a significant interaction effect of treatment and study habits on the student's performance in physics at P<0.05 level of significance. Thus, Ho3 was rejected.

9. Summary of Findings

1. There is a significant main effect of treatment (flipped classroom and in pen and talk methods) on students' achievement in physics.
2. There is a significant main effect of study habits on students' achievement in physics.

3. There is a significant interaction effect of treatments and study habits on students' performance in physics.
4. Students in the flipped engagement group performed excellently better ($\bar{x}$ =36.05) than students in pen and talk($\bar{x}$ =26.06)

10. Discussion of Findings

The study has found a significant main effect of treatment on the academic performance of students in physics. The physics students who were exposed to flipped classroom engagement strategy performed better than their counterparts who were exposed to the pen-and-talk method this is because the flipped classroom engagement used multimedia in teaching with engagement, and collaborative learning as well as other 21st-century approaches in both outside the classroom and in the classroom. It is an innovative method of learning in the field of education because of the integration of ICT into students' pre-classroom activities (Siguroardottir & Heijstra, 2020). The strategy allowed students to learn at their own pace and be more responsible for their learning with some students classifying this as a "sink or swim" (Avery et al., 2018). Also, students in flipped classroom engagement prefer teaching themselves the content of the lesson rather than learning them from the teacher (Miles & Foggett, 2016). The video section increased the interaction between teachers and students (Hodgson et al., 2017).
Flipped classrooms increased academic performance (Alsalhi et al., 2021). The strategy has various types of learning that take place every day such as hands-on activities that entice kinesthetic learners, videos that help visual learners, as well as many others.

These different types of learning are not necessarily a part of the traditional classroom, where students claim they get bored more often due to the repetition of the same type of lectures and learning that takes place every day (Avery et al., 2018; Sun & Wu, 2016). This teaching strategy also helps students challenge themselves since none of the students wants to be left behind in the course of their group discussions and other classroom activities. It was observed that every student is eager to be in the spotlight; they all want to express themselves by sharing what they know with their colleagues since they had the privilege to watch the video lessons many times which helped them gain sufficient knowledge before coming to the class. Moreover, for them, collaborative work triggered sharing of thoughts and learning from the videos hence, group activities helped them build their friendship. This gesture shows an increased level of confidence in group discussions and other activities. Therefore, flipped classroom engagement students are more motivated and active to participate in learning activities. All the benefits of flipped classroom engagement accounted for the superiority of flipped classroom engagement over the pen-and-talk method of instruction.

Generally, this finding corresponds to several earlier studies that also confirmed blended learning made positive impacts on students' performance (Dakhi & Ifran, 2020; Alsalhi, Al-Qatawneh, Eltahir & Agel, 2019) and increased student-teacher interactions (Asif & Shehzad, 2019; Hrastinski, 2019; Krasnova & Shurygin, 2019). This result supports the findings of Abraham and Onyema (2020), Thai et al. 2017; Casasola et al., 2017; Sun and Wu (2016) that students in the flipped engagement instructional strategy performed better than students in the conventional method of instruction. However, the results of this study did not agree with the results of Tosun, (2015) who found that the use of blended learning had no significant effect on the performance of English language students in vocabulary.

Further, the study found there was a significant main effect of study habits on academic achievement

in physics. This is because students who possess good study habits read as at when due, do assignments and submit on time perform better than those who have poor study habits. It, therefore, implies that a teacher could adopt the best instructional strategies, utilise suitable instructional materials, and create a conducive atmosphere for learning however, without a good study habits, the student might yet perform poorly in a test or an examination. This finding is supported by the findings of Rabia, Mubarak, Talat and Nasir (2017), Alsancak-Sirakaya and Ozdemir (2018) on the impact of study habits on the performance of students. This finding, however, disagrees with the findings of (Azzopardi & Camilleri 2018).

This study also reveals that there is a significant interaction effect between treatments and study habits on students' performance in physics. This is because flipped classroom engagement motivates the students to devote more time to studying physics, solving physics problems, doing homework and assignment, allocating enough time to reading and note-taking, study period procedures, concentration, written work, examinations, and teacher consultation more than those in the conventional. The improved study habit caused by flipped engagement enhanced improved performance in physics. Therefore, to achieve quality physics education for sustainable development, flipped classroom engagement should be adopted as a method of instruction because it allows students to adequately prepare for each lesson, with the preparation tasks focused and linking these tasks with classroom activities.

11. Conclusion

The study has found that flipped classroom engagement proved superior to the pen-and-talk method of instruction on the performance of students in physics. Also, study habits improved the performance of students in physics flipped classroom engagement. It therefore, follows that flipped classroom engagement should be used to achieve quality physics education for sustainable development because it is a form of blended learning which allow students to adequately prepare for a lesson by watching a video on the topic of the lesson before coming to the classroom this assist them to make active participation in the classroom activities

12. Recommendations

1. Flipped classroom engagement is recommended for physics teaching at the secondary school level. Achieving quality physics education for sustainable development.
2. Good study habit is recommended for physics students to achieve quality physics education for sustainable development.
3. Flipped classroom engagement is recommended for improving physics students' study habits for achieving quality physics education for sustainable development.
4. Physics teachers should give priority to students' preparation for physics lessons.
5. Physics teacher should link the preparation section (video watching) with the classroom activities.

13. References

Abraham, L.N. & Onyema, C. (2020), Effect of blended learning on student's academic performance in physics in federal colleges of education in Southeast, Nigeria, *British Journal of Education*, *8*(1), 66-77.

Abu-Hilal, M. & Al Abed, A. (2019). Relations among engagement, self-efficacy, and anxiety in mathematics among Omani students. *Electronic Journal of Research in Educational*

Psychology, 17(2), 241-266.

Adolphus, T. Ekineh, D.R. & Aderonmu, T.S.B. (2021). Teaching strategies and secondary school physics students' enrolment and academic attainment in River state, Nigeria: implications for teaching and learning of physics in schools. *International Journal of Research and Innovation in Social Science (IJRISS)*,5(1), 236-246

Alsalhi, N. R., Eltahir, M. E. & Al-Qatawneh, S. S. (2019). The effect of blended learning on the achievement of ninth-grade students in science and their attitudes towards its use. *Heliyon, 5*(9). 1-11 https://doi.org/10.1016/j.heliyon.2019.e02424

Alsancak-Sirakaya, D, & Ozdemir, S. (2018). The effect of flipped classroom model on academic achievement, self-directed learning, readiness, motivation, and retention. *Malaysia*n. *online journal of Education.6*(2) 60-74.

Alva, M. (2017). Self-esteem, study habits and academic performance among university students. https://files.eric.ed.gov/fulltext/EJ11393 45.pdfalva

Asif, A. & Shehzad, (2019). Impact of blended learning on teaching and learning of physics: teachers' and students' perception at secondary level. *Sir Syed Journal of Education & Social Research (SJESR)*. 2(1), pp. 110-127. 2019 (Jan July) ISSN 2706-6525 (online).

Assem, H. D., Nartey, L, Appiah, E & Aidoo, J.K (2023). A Review of student's academic performance in physics: attitude, instructional methods, misconceptions, and teachers' qualification. *European Journal of Education and Pedagogy.Doi:10.24018/ejedu.20234.1551*

Avery, K.F.G., Huggan, C.T. & Preston, J.P. (2018). The flipped classroom: high school student engagement through 21st-century learning. *in education.* 24(1).4-21. Retrieved from www.ineducation.ca.

Azzopardi, M. & Camilleri, L. (2018). Study habits and level of difficulty encountered by Malthese students studying Biology advanced level topics. IJARW *2* issue 4 https://waset.org/abstracts/78038

Bakare, C.G.M. (1977).*Study habits inventory(SHM).*University of Ibadan

Bawan, A.N. & Udo, N.S. (2019). effect of innovative teaching methods in physics on the academic performance of secondary school students in akampa local government area. *British Journal of Education, Learning and Development Psychology*, 2(1), 89

Bouilheres, F, Lethi, Mc Donald, S, Nkhoma, C & Jandug, L. (2020). Defining student learning experience through blended learning. *Education and Information Technologies 25*(1)1-21Doi:10.1007/s10639-020-10100-y

Casasola, T, Nguyen, T & Warschauer, M (2017). Can flipping the classroom work? Evidence from undergraduate chemistry. *International journal of teaching and learning in higher education,*29 (3),421-435.http:/www.iset.org/ijtihe

Coffie, I, S., Frempong, B. B., & Appiah, E. (2020). Teaching and learning Physics in senior high schools in Ghana: the challenges and the way forward. *Advance in Research*, 21(3), 35-42.

Dakhi, O. & Irfan D. (2020) Blended learning: a 21st-century learning model at college. *Int J Multi Sci.* 1(08), 50–65

Fouche, J.P. (2017). The reported study habit and time-management trends of post-graduate students in accountancy. *31*(6) http://www.journals.ac.za/index.php/sajhe/article/view/1356.

Hadiyanto, H. (2019). The EFL Students' 21st Century Skill Practices through E-Learning Activities. *IRJE (Indonesian Research Journal in Education).* 3(2). 461-473. https://doi.org/10.22437/irje.v3i2.8036

Hrastinski. S. (2019). What do we mean by blended learning? Tech Trends. 63(5), 564–569. Doi:10.1007/s11528-019-00375

Hodgoson, T. R, McGee, D & Kinne, L. J.(2017).Assessing behaviour engagement in flipped and non-flipped mathematics classroom: Teacher abilities and other factors, ERIC Publications

International Institute for Sustainable Development (IISD). https://www.iisd.org

Irvine, J. (2020). Positively influencing student engagement and attitude in mathematics through an instructional intervention using reform mathematics principles. *Journal of Education and Learning,* 9(2), 48-75.

Isa, S. G., Mammam, M. A., Badar, Y. & Bala, T. (2020). "The impact of teaching methods on academic performance of secondary school students in Nigeria", *International Journal of Development Research,* 10(6), pp. 37382-37385.

Jordan, G. (2021). "The Effects That a Flipped Classroom has on Engagement and Academic Performance for High School Mathematics Students". Dissertations, Theses, and Projects. 543 https://red.mnstate.edu/thesis/543

Kelly, M. (2019). The new version of Bloom's taxonomy. *Bloom Taxonomy-Application Category*

Krasnova, L. & Shurygin, V. (2019). Blended Learning of Physics in the Context of theProfessional Development of Teachers. *International Journal of Emerging Technologies in Learning (iJET),* 14 (23), https://doi.org/10.3991/ijet.v14i23.11084Dissertations,Theses, and Projects.543. https://red.mnstate.edu/thesis/543

Lawson, D.F., Stevenson, K.T., Peterson, M.N. *et al*. Children can foster climate change concerns among their parents. Nat. Clim, Chang. 9, 458-462 (2019). https://doi.org/10.1038/s41558-019-0463-3

Malavoloneque, Q & Costa N.(2020).Physics education and sustainable development: A study of energy in a global perspective in an Angolan initial teacher education schools. *Brief Research Report* 1-11 doi:3389/fedu.2021.639388.

Mayer, R.E. (2009). *Multimedia learning (2nd.ed).* Cambridge University Press.http;//doi.org/10.1017/cb097.

McGraw .H (2019). Richard Mayer's cognitive theory of multimedia learning. Retrieved from mheducation, ca/ on 01/02/2023

Meremikwu, A. N., & Ibok, E. E. (2020). Influence of classroom environment on senior secondary school student academic achievement in mathematics in Calabar Nigeria. *Educational Research and Reviews,* 15(8), 495-503

Ntibi, J.E. and Ekpenyong, E.I. (2020). Effect of self-directed learning instructional strategy on students' achievement and retention in Mathematics and Physics in Calabar Municipality of Cross River State, Nigeria, *Prestige Journal of Education,* 3(2), 75- 85

Oriogu Chuks Daniel, Subair Roslyn Esoname, Oriogu-Ogbuiyi DarlinaChima, Ogbuiyi Sussan Udoaku. Effect of Reading Habits on the Academic Performance of Students: A case study of the students of Afe Babalola University, Ado Ekiti, Ekiti State. *Teacher Education and Curriculum Studies*. Vol. 2, No 5, 2017, pp 74-80.

Ozkal, N. (2019). Relationships between self-efficacy beliefs, engagement, and academic performance in math lessons. *Cypriot Journal of Educational Science,* 14(2), 190-200.

Rabia, M. Mubarak, N, Tallat, H &Nasir, W. (2017). A study-on-study habits and academic performance of students, *International Journal of Asian Social Science*, 7(10), 891-897

Sigurðardóttir, M. S., & Heijstra, T. M. (2020). Mixed approaches to learning in the flippedclassroom: How students approach the learning environment. *The Canadian Journal for the Scholarship of Teaching and Learning*, 11(1). https://doi.org/10.5206/cjsotlrcacea.2020.1.8098

Sun, J.C. Y & Wu, Y.T. (2016). Analysis of learning achievement and teacher-student interactions in Flipped and conventional classrooms. The International Review of Research in Open and distributed learning 17,79-99;https/doi.org/10.19173/irrodi,v17i1.2116

Tosun, S. (2015). The effect of blended learning on EFL students' vocabulary enhancement *Procedia-*

social and behavioural sciences 199.641-647 Doi,10.1016/sbspro 2015 07592

Thai, N.T.T., De Wever, B., and Valcke, M. (2017). The impact of a flipped classroom design on learning performance in higher education: looking for the best "blend" of lectures and guiding questions with feedback. Computers & Education, 107,113-126. DOI:https://doi.org/10.1016/j.compedu.2017.01.0 03

United Nations Sustainable Development Summit 2015. https://sdgs.un.org/publications/global-sustainable-development-report-2015- advance-unedited-version-gsdr-2015-17874

White, P. J., Naidu, S. Yuriev, E., Short, J. L., McLaughlin, J. E. & Larson I.C. (2017). Student Engagement with flipped classroom teaching design affect pharmacology examination performance in a manner dependent on question type. *American Journal of Pharmaceutical Education*.81(9):5931.dio:10.5688/ajpe 593