



# The use of e-books to improve the academic performance of students in the subject of Physics: implications for counselling

*El uso de libros electrónicos para mejorar el rendimiento académico de los estudiantes en la asignatura de Física: implicaciones para la orientación*

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## ABSTRACT

The utilization of ICT resources has the potential to improve teaching and learning, according to the literature. To ascertain the possible influence of e-books on students' achievement in physics, no empirical research has been done in Nigeria. Hence the need for this study. Utilizing a simple repeated measures research design, this study was driven by a quantitative research methodology. The study included 58 senior secondary two (2) physics students who were randomly selected from secondary schools in the Nsukka Education zone. The Physics Achievement Test (PAT), which has been trial tested and face and content validated, was used to collect the data. The internal consistency dependability for the PAT components was .76. The repeated measures analysis of variance was used to analyze the data collected. It was discovered that the learners' access to e-books significantly impacted ( $p < .05$ ) how well they performed in Physics. This research finding has implications for counselling in that teachers and their schools need to be provided educational guidance and counselling by the librarian-counsellor on the legal and ethical implications of using ICT resources like e-books to deliver physics instructions in schools.

**KEYWORDS** achievement; physics; grade three learners; ICT resources.

## RESUMEN

La utilización de los recursos TIC tiene el potencial de mejorar la enseñanza y el aprendizaje, según la literatura. Para determinar la posible influencia de los libros electrónicos en el rendimiento de los estudiantes en física, no se ha realizado ninguna investigación empírica en Nigeria. De ahí la necesidad de este estudio. Utilizando un diseño de investigación simple

de medidas repetidas, este estudio fue impulsado por una metodología de investigación cuantitativa. El estudio incluyó a 58 estudiantes de física de secundaria superior dos (2) que fueron seleccionados al azar de escuelas secundarias en la zona educativa de Nsukka. Para recopilar los datos se utilizó el Physics Achievement Test (PAT), que ha sido probado y validado de cara y contenido. La confiabilidad de consistencia interna para los componentes PAT fue .76. Se utilizó el análisis de varianza de medidas repetidas para analizar los datos recopilados. Se descubrió que el acceso de los alumnos a los libros electrónicos tuvo un impacto significativo ( $p < .05$ ) en su desempeño en Física. Este hallazgo de investigación tiene implicaciones para el asesoramiento en el sentido de que los maestros y sus escuelas deben recibir orientación educativa y asesoramiento por parte del bibliotecario-consejero sobre las implicaciones legales y éticas del uso de recursos de TIC como libros electrónicos para impartir instrucciones de física en las escuelas.

**PALABRAS CLAVE** logro; física; estudiantes de tercer grado; recursos TIC.

## 1. INTRODUCTION

Prior to the emergence of coronavirus 2019, the temporary suspension of face-to-face instruction during the pandemic had a huge impact on how students learned (Ardi et al., 2022; Eze et al., 2021). Most industrialized nations resorted to online learning when the pandemic was at its worst, while the majority of developing nations closed all of their schools. One of the causes of this was the dearth of web resources in those developing nations. The use of information and communication technology (ICT) resources has been demonstrated in the literature to have the ability to enhance teaching and learning (Ugwuanyi et al., 2021). Also, ICT resource stimulates greater interest, initiative, and participation from the student body and allows for more autonomous learning on the side of the learners (Cupido, & Suárez, 2022; Marín-Díaz et al., 2022). The rapid development of ICT in the twenty-first century has changed and impacted human learning (Kwangmuang et al., 2021).

To represent modern society, the learning management model needs to be modified (Kwangmuang et al., 2021). Due to the rapid development of electronic publication, libraries are not only acquiring reading materials like printed books and journals but also setting up access to a wide range of learning resources in electronic form called e-books. The appeal of electronic resources has skyrocketed as a result. The majority of the global literature is found in e-resources. E-resources include, but are not limited to, e-books, e-journals, databases, CDs/DVDs, e-conference proceedings, reports, maps, pictures/photos, e-newspapers, the Internet/websites, listservs, newsgroups, subject gateways among others (Ugwuanyi, 2022a). More and more print sources are being converted to digital format. The multidisciplinary technology era we live in has led to a proliferation of e-books and other innovations in the market (Korat et al., 2014). Academics commonly use electronic resources as information sources. Around the world, educational institutions are phasing out textbooks (Almekhlafi, 2021). E-books have a number of benefits, such as being much cheaper to purchase online than in physical bookstores (Sung, & Chiu, 2022), being easier to access when traveling, and being portable enough for users to carry hundreds of volumes with them everywhere they go (Casselden, & Pears, 2020). Also, e-books are maintained in the reader's online personal account. As e-books have a "search feature", readers may quickly seek for any information without wasting time turning pages

(Casselden, & Pears, 2020). The majority of e-books are cloud-based, and one can bookmark the page after searching. As a result, writers and authors can instantly update the connections online. E-books come with interactive features to make reading them more enjoyable. These include voice, video, and animations that are great for kids and those who are blind (Khoshimova, 2021).

E-books' disadvantages include the need for a power source, such as a battery. As a result, the reader is prevented from accessing e-books if the battery is not charged and a power source is not available. This causes a great deal of inconvenience; files cannot be downloaded on e-book devices without the proper software; notifications on the e-books device readers. This is more noticeable in phones or tablets because of how quickly technology changes. E-books must be updated in accordance with this. Failure to do so will put saved files, books, and document formatting at risk. There are health risks associated with reading at night, especially on tablets and with e-readers that have backlights. It may result in poor sleep, eye strain, and/or health problems.

### 1.1. Related works

Studies have been conducted on the effect of e-books on students' performance. A study was conducted by Dudung et al. (2022) to ascertain the impact of e-readiness, e-learning, and e-books on graduate students' performance. Graduate students made up the research population, and 210 doctorate students in Jakarta comprised the sample. The research strategy used was an associative survey method. The findings indicated that e-readiness, e-learning, and e-books had an impact on graduate accomplishment. Almekhlafi (2021) sought to determine how e-books affected the way students learned technological course material and to gauge how helpful e-books were perceived by preservice student teachers. Two experimental groups and one control group were used in the study's quasi-experimental, three-group pretest-posttest design. Participants were United Arab Emirates University pre-service student teachers taking a technology course. An iBook was utilized in the first experimental group, a PDF version of the same e-book was used in the second, and a physical copy of the same e-book was used in the third. All subjects also received a post-treatment questionnaire. Preservice teachers reported greater benefits and fewer drawbacks of the interactive version of the e-book compared to the other versions, and they had a considerably more favorable attitude about the utility of the interactive version for content learning. The findings, however, did not indicate any appreciable variation in students' mastery of the course material according to the types of book utilized.

To ascertain the effects of mathematics e-books on students' mathematics achievement, Wijaya et al. (2022) carried out a meta-analysis. This quantitative study used data from 17 studies with 26 effect sizes. The gathered information was utilized to examine the moderating effects of e-book type, degree of education, publication year, sample size, and treatment length on students' mathematical achievement. The findings revealed that consuming math e-books generally has a significant impact ( $g = 0.82$ ) on pupils' mathematical achievement. Additionally, adopting e-books has a major impact on pre-school pupils who are more adept at using technology, and has no impact on students' mathematical achievement in publication year. Zhao et al. (2021) used a gamified interactive e-book approach to assist a flipped mathematics classroom. A quasi-experimental study was implemented in an elementary school mathematics course to assess the efficacy of the suggested approach. There were three groups: the GIEBFL group, the CFL group, and the traditional education group. The GIEBFL group was made up of students who used the gamified interactive e-book in

the mathematics flipped classroom (the TI group). A paper-and-pencil test revealed that the GIEBFL students greatly outperformed the CFL and TI students in terms of performance. Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, Susilawati et al. (2022) carried out a systematic review. ScienceDirect, ERIC, ProQuest, Pubmed, and Wiley Online Library were searched for pertinent articles with a publication year of 2010-2021. The PICOS guidelines were used to determine eligibility requirements. After gathering the publications' key conclusions, designs, and applicable techniques, they were each given a thematic analysis. It was found that multimedia e-books enhanced students' learning processes more significantly than traditional instructional approaches.

Wilujeng and Lestari (2022) looked at how using interactive multimedia e-books affected the interest of lower-secondary school pupils in a science course. It used a quasi-experimental design with 64 students (ages 12 to 14) from a public lower-secondary in the Indonesian city of Yogyakarta are divided into the experimental (n=32) and control (n=32) groups. Whereas the control group used printed textbooks, the experimental group used interactive multimedia e-books. The hypothesis was tested using an independent and paired sample t-test with a significance level of 0.05. (data from the questionnaire). The use of interactive multimedia e-books increased students' interest in science courses significantly, according to the results of the paired sample t-test. Sari et al. (2022) studies how e-books can help students develop their skills for the 21st century based on the fact that many studies have been done on e-books and their use in high schools. Using physics learners, the researchers found that usage of e-books enhanced student learning performance, which in turn affected students' 21st century skills.

Sung et al. (2022) created an interactive e-book system based on the contextual learning paradigm to provide an interactive interpretation of the Analects of Confucius. To assess the effectiveness of the suggested technique, a quasi-experiment was carried out. 38 fifth graders from two classes at an elementary school in northern Taiwan participated in the study. They were split into an experimental and a control group. While learning the Analects of Confucius, the experimental group used an interactive e-book while the control group employed a traditional technology-enhanced teaching method. The findings demonstrated that using an interactive e-book to teach the Analects of Confucius in an elementary school course can improve students' learning motivation and achievement. Green et al. (2016) looked into an alternative testing method utilized in a managerial accounting course for undergraduates. They theorized that regular open-book testing strategies will improve learning and better equip students for the kind of decision-making they will face in the real world. Pre-quizzes and major exams were all open-book, with a mix of closed-book and open-book pre-quizzes throughout the whole semester. Findings showed that open-book final examinations were the only major exams where students who took open-book pre-quizzes fared higher. Results from their study also showed that students appreciated their textbooks more and used them regularly and extensively to prepare for class by utilizing open-book testing protocols rather than using conventional closed-book testing methods. Sun and Pan (2021) looked into how students' creativity and learning motivation might be increased through the usage of information technology in the classroom. The experimental study involved 232 college students from the province of Fujian. The findings demonstrated how the use of information technology in e-book instruction closes the gap between teachers and students and fosters a deeper comprehension of their learning needs, opening up new opportunities for lesson planning and instructional strategies.

On the basis of the aforementioned, it can be seen that e-books are real resources for raising student achievement in both science and the arts. It is important to highlight that few studies have been conducted on physics ideas, with the majority of studies on this topic focusing mostly on literacy and numeracy. Thus, the purpose of this study was to investigate how e-books affected students' performance in physics.

## 1.2. Hypothesis

For the study, a single hypothesis with a 5% chance of being correct was put forth:

- Ho: E-books have no significant effect on student learning achievement in physics.

## 2. METHOD

### 2.1. Research paradigm, approach and design

The research paradigm for this study was postpositivist and scientific research paradigm. This is because the testing of the hypothesis led to the production of the study findings. Because the participant characteristics were defined and presented objectively, a quantitative research approach was adopted. Based on this method, a simple repeated measures research design guided the conduct of this research. This strategy is based on several assessments of the dependent variable at varied test intervals both before and after treatment. The choice of this design is because compared to other designs, it has more statistical power. Consequently, this kind of design can have significantly greater statistical power by accounting for subject differences. The statistical test for this design is more likely to find an effect if one exists. In this research, this design was applied by first administering pretests 1 and 2 to the participants at two weeks interval before the commencement of the treatment. Thereafter, the treatment started and after the treatment period, posttests 1 and 2 were administered at two weeks interval. Similar recent studies have adopted similar design (Ugwuanyi et al., 2020a; Ugwuanyi et al., 2020b; Ugwuanyi et al., 2021; Ugwuanyi, 2022b).

### 2.2. Participants

Fifty-eight (58) SS2 students of physics from secondary schools in Nsukka Education Zone, Enugu State, Nigeria were randomly chosen for the study. Two secondary schools in Nsukka Education Zone were specifically chosen for this sampling. Purposive sampling was used to ensure that secondary schools with computer and internet facilities were sampled because the study's treatment involved exposure to the use of e-books.

### 2.3. Instrument for data collection

The researchers' developed physics achievement test (PAT) was used to gather data. A 20-item multiple-choice questions with only one right response each was used for data collection (see Appendix A for the PAT items). The possibilities for each question were A, B, C, and D. These questions were generated using concepts from senior secondary two (2) Physics curriculum. A maximum score of 60 points and a minimum score of 0 were achieved by awarding two points for each right response.

The PAT's content and face validities were ascertained prior to trial testing. The validity of PAT's content was confirmed using the Table of Specifications. Then, face validation was conducted by two specialists in physics education and one in educational measurement/evaluation. The language of the PAT items, their suitability for the student's level of ability, and their relevance to the research aim, among other factors, were all addressed by these experts in their helpful input. After that, the PAT was modified using the validators' feedback.

After being face validated, the modified PAT was put to the test on 20 SS 2 students who were not involved in the study. The data were subjected to Kuder-Richardson's 20 (K-R 20) reliability estimate in order to determine the internal consistency/dependability of the PAT items, which produced a reliability index of .76.

## **2.4. Procedure**

The research ethics committee at the University of Nigeria approved the study. Prior to the start of the research, informed consent forms were also delivered to the participants' teachers. These forms were correctly completed and signed by the parties involved.

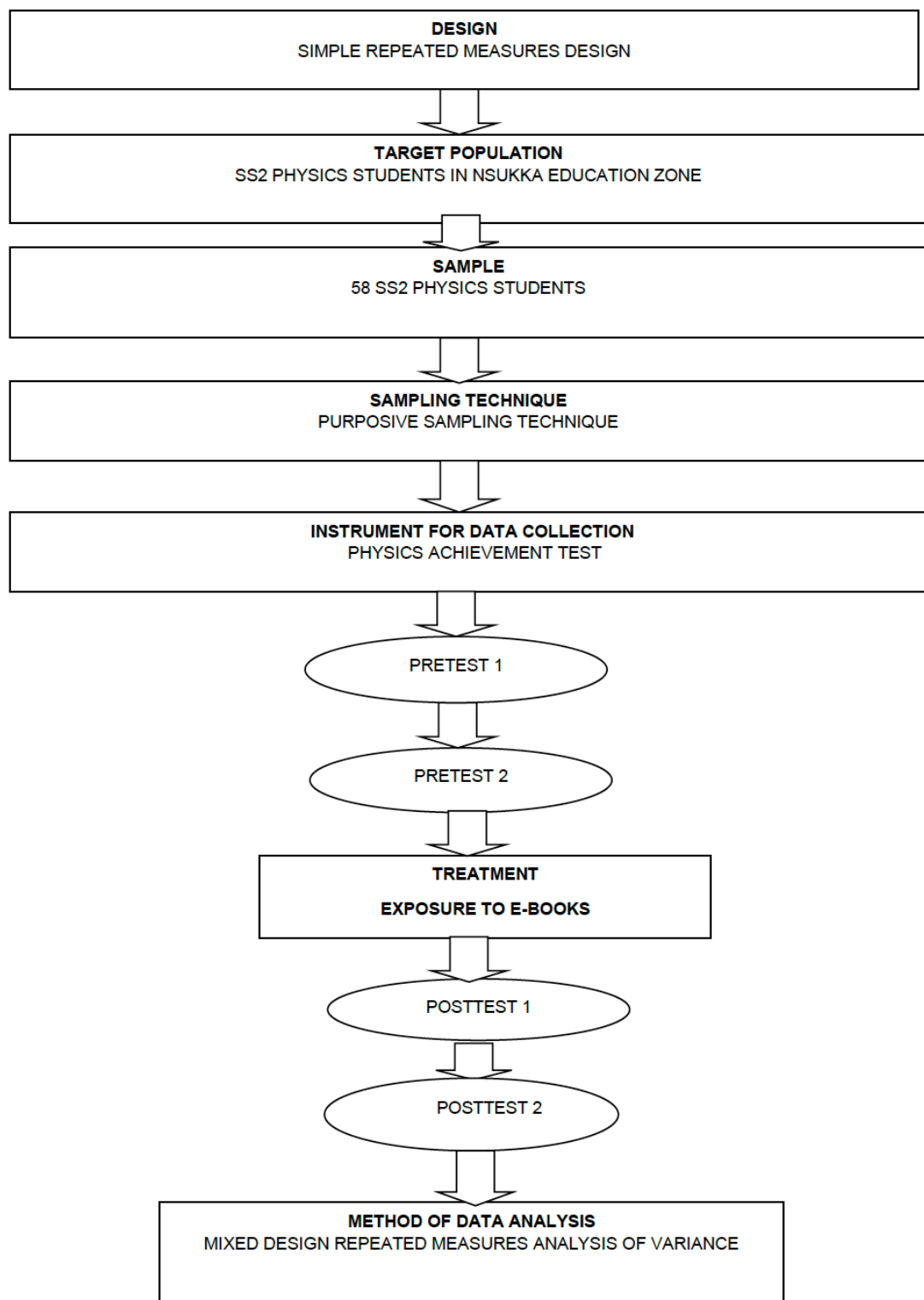
Before the start of the treatment, there were two sets of pre-testing spaced two weeks apart. The baseline data for the study could then be gathered by the researchers. Then, the treatment sessions started. The learners were exposed to e-books while learning about physics principles. E-books were used to teach physics concepts like machines, electricity, energy, and temperature. The students were instructed on these topics by exposing them to numerous ICT resources in the form of e-books that shared comparable ideas. This exposure was repeated four times over a four-week period. At every session, the teachers encouraged the students to raise questions regarding the material they were having trouble understanding. At the end of the treatment, the subjects received the PAT that had been reshuffled for the initial posttest. After two weeks of administering the first posttest, the second posttest was administered. The different measurement scores both before and after treatment were then arranged and cleaned in order to prepare for data analysis.

## **2.5. Data analysis**

The study's research question was answered using descriptive statistics and the hypothesis testing was performed using repeated measures ANOVA at 0.05 probability level. The following steps were taken to analyze the data. The first step was to perform descriptive analyses of each tests administered to students. The second step involved the use of repeated measures ANOVA to ascertain the effect of e-books on students' achievement in physics. The following preliminary analysis were also carried out to ensure that the research data met the conditions for this kind of statistical test: sphericity test (Mauchly), normality test, homogeneity test (Levene's test) and pairwise comparisons with Bonferroni test (Guillén et al., 2020). The dependent variable, physics achievement, was evaluated in four time points to determine intra-group variations. SPSS version 26 was used for the analysis.

Figure 1 provides a summary of the study's research plan.

**FIGURE 1.** Schematic Representation of the Research Method.



### 3. RESULTS

The results were presented in line with results of the mean and standard deviation for each test. Mean was the measure of central tendencies while standard deviation was the measure of dispersion used for the data analysis.

Table 1 showed that the mean achievement scores of the students at pretests 1 and 2 are (M = 18.36, SD = 5.61) and (M = 18.81, SD = 5.42) while at posttests 1 and 2, their mean achievements are (M = 47.44, SD = 14.31) and (M = 49.72, SD = 13.92). This shows that the students' achievement in physics improved greatly at the posttests 1 and 2 after being exposed to e-books.

**TABLE 1.** Mean analysis of the scores of the student at pretests and posttests

Tests	N	Mean	Std. Deviation
Pretest 1	58	18.36	5.61
Pretest 2	58	18.81	5.42
Posttest 1	58	47.44	14.31
Posttest 2	58	49.72	13.92

Before the analysis in Table 2, the normality of the data was verified accordingly using the Box's M test. In addition, by observing the normal Q-Q and Q-Q graphs without a trend, it is verified that the distributions are close to normality in each of the subgroups of the measurement variable. Box's M test (M = 15.654; p = .356) allowed for the non rejection of the null hypothesis of equality of variance-covariance matrices and, therefore, it is concluded that the groups are equal.

On the other hand, the Levene test determined that the assumption of homogeneity of the variances was fulfilled, in the three intra-subjects factors: before, F (1, 64) = 0.001, p = 0.989; during, F(1, 64) = 0.812, p = 0.371; and after, F (1, 64) = 0.967, p = 0.390.

Lastly, the Mauchly sphericity test was not significant, thereby fulfilling the variance sphericity assumption, Mauchly W = .819, p = .276.

**TABLE 2.** Repeated measures analysis of variance of the difference in the test occasions

	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	52356.034	3	17452.011	185.464	.000	.765
Error (Time)	Sphericity Assumed	16090.966	171	94.099			

Table 2 revealed that e-books had a significant impact on the achievement of students in physics, F (3, 171) = 185.464, p < .05,  $\eta^2 = .765$ . This implies that the null hypothesis was rejected (p < .05). Moreover, the effect size of .765 suggests that there is a large effect size of the experimental manipulation on students' achievement in physics. Regardless of the scale that was used to measure the dependent variable, effect size, in the opinion of Lakens (2013), enables researchers to portray the magnitude of the reported effects in a standardized metric that can be understood. Instead of just presenting the statistical significance, such normalized impact sizes enable researchers to express the practical significance of their findings (i.e., the implications of the findings to everyday life).



**TABLE 3.** Pairwise comparisons with Bonferroni test

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
1	2	-.052	.038	1.000	-.156	.053
	3	-29.155*	.503	.000	-30.531	-27.779
	4	-30.483*	.328	.000	-31.380	-29.585
2	1	.052	.038	1.000	-.053	.156
	3	-29.103*	.501	.000	-30.474	-27.733
	4	-30.431*	.329	.000	-31.331	-29.531
3	1	29.155*	.503	.000	27.779	30.531
	2	29.103*	.501	.000	27.733	30.474
	4	-1.328*	.423	.016	-2.483	-.172
4	1	30.483*	.328	.000	29.585	31.380
	2	30.431*	.329	.000	29.531	31.331
	3	1.328*	.423	.016	.172	2.483

Based on estimated marginal means  
 \*. The mean difference is significant at the .05 level.  
 b. Adjustment for multiple comparisons: Bonferroni.

The pairwise comparisons with Bonferroni tests in Table 3 showed that the mean differences between posttest 2 (Time 4) and pretest 1 (Time 1); posttest 2 (Time 4) and pretset 2 (Time 2) had the highest positive mean difference and thus contributed most to the significant effect of e-books on students’ achievement in physics.

## 4. DISCUSSION

The goal of this study was to ascertain the possible influence of using e-books on students’ physics achievement. The use of e-books was found to have a very high significant influence on students’ achievement in physics, accounting for 76.5% of the improvement in their performance, using a straightforward repeated measures approach. This result is highly desired because it confirms the findings of the study and the researchers’ experience throughout the intervention. The intervention in this example provided the students with plenty of opportunities to investigate physics issues by utilizing e-books under supervised circumstances. In this instance, the students were closely watched to make sure they did not have access to any resources besides those that were physics-related. Buttressing the findings of this research are the findings of Almekhlafi (2021), Dudung et al. (2022), Sari et al. (2022), Susilawati et al. (2022), Wijaya et al. (2022), Wilujeng et al. (2022) and Zhao et al. (2021). Dudung et al. (2022) found that e-books had significant impact on graduate students’ performance. Almekhlafi (2021) revealed that students’ mastery of the course material improved after being exposed to the sue of e-books. Wijaya et al. (2022) found that e-books had significant effect on students’ mathematics achievement. Zhao et al. (2021) revealed that the used a gamified interactive e-book approach had significant effect on students’ performance. Moreover, Susilawati et al. (2022) the usage of multimedia e-books had a significant impact on how well health sciences students learn. Wilujeng et al.

(2022) showed that the use of interactive multimedia e-books significantly affected the interest of lower-secondary school pupils in a science course. Also, Sari et al. (2022) found that the usage of e-books enhanced student learning performance, which in turn affected students' 21st century skills.

The use of electronic books had a considerable impact on students' Physics performance (Ugwuanyi et al., 2022a). E-books can assist students at various levels in learning word meanings (Baskar, 2017). The e-book engagement had a significant long-term vocabulary impact (Shamir et al., 2018). Students in both learning groups improved their overall emerging literacy skills after encountering technological materials (Korat, & Shamir, 2008). According to another study, using electronic books or other versions of stories may cause students to become diverted from the plot, especially if they can interact with the screen and/or play games inside the text (Chen et al., 2020). According to a similar study, students often become familiar with e-books and enjoy the technology rapidly (Jones et al., 2011). The results of a study showed that the experimental group's academic performance changed between the pre- and post-test, demonstrating the usefulness of employing digital storytelling to teach scientific subjects (Shemy, 2020). According to the study's findings, students who taught statistics utilizing interactive electronic tools performed better academically than those who acquired statistics the traditional way (Lim et al., 2020).

#### **4.1. Implications for Counselling**

This research finding has implications for counselling in that teachers and their schools need to be provided educational guidance and counselling by the librarian-counsellor on the legal and ethical implications of using ICT resources like e-books to deliver physics instructions in schools. ICT resources assist in the efficient dissemination of information to all types of users, foster collaborative research efforts, stimulate the creation and dissemination of new knowledge through the use of communication network tools, and encourage the use of such tools (Dukper et al., 2019). According to a study on the effects of electronic resources on learning, students learned more from electronic resources than did adults (Almekhlafi, 2021). Electronic resources improved the performance of low and average performers (Chen et al., 2020). Nearly all students believed that digital literacy was essential for both academic and personal communication and information gathering (Chen et al., 2020). Given that digital technology makes teaching and learning more efficient, fun, and rapid (Baskar, 2017), providing schools with guidance on how to deploy and use e-books without infringement of relevant copyright laws should be prioritized by the librarian-counsellor. The teachers, school principals and districts should be properly guided by the librarian-counsellors on how e-books can be effectively utilized in teaching and learning to promote the desired learning outcomes among students. The librarian-counsellor can also guide and mentor students and teachers on how to navigate virtual libraries (Eseadi, 2022) by equipping them with requisite digital library use skills which would facilitate the efficient use of e-books and other digital library resources by students and teachers.

## **5. CONCLUSIONS**

This study sought to ascertain the effectiveness of e-books on students' achievement in physics and found that e-books had a significant impact on students' physics achievement, according to this study, accounting

for a 95.4% increase in that achievement. This implies that usage of e-books improves students achievement in physics. Based on that, the researchers concluded that e-books have a considerable impact on students' physics achievement. In order to make it easier for secondary school teachers to use e-books to teach physics and other relevant courses, it is recommended that the Local Education Authority provide them with enough access to e-books.

The finding of this research may have been limited by some factors such as the number of schools used for the study. During the conduct of this study, the researchers could not find enough schools with ICT facilities and thus were able to use only two schools that were identified as having ICT facilities. This few number of schools that participated in the study may affect the generalizability of the findings to the entire population of secondary schools in the study area. The study did not include a comparison group as a result it was not possible to ascertain if the use of e-books will be better than or similar to the use of any other ICT resources in the teaching of physics. Thus, it was suggested that future researchers should replicate this research by using more schools from where more participants can be sampled and comparing the effects of e-books with other learning resources in promoting students' physics achievement. It is also crucial that future researchers should consider the analysis of the demographics of the participants like gender in replicating this study. This will help to empirically validate the influence of the potential moderators on the effectiveness of e-books on students' achievement in physics.

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## APPENDIX A

### Physics Achievement Test (PAT)

**Instruction:** Please use pen to tick the alphabet that bears the correct answer to each of the following questions.

Time allowed: 20 Minutes.

1. Which of the following statements is NOT true? Mercury is used in a thermometer in preference to alcohol because
  - A. It is easily seen
  - B. It does not wet the glass
  - C. It is a better conductor of heat than alcohol
  - D. It has a lower freezer point
2. Which of the following does not rely on the principle of moments for its operation?
  - A. Block and tackle
  - B. Pliers
  - C. Screw-jack
  - D. Spanner

3. Friction in a machine is likely to reduce the (i) velocity ratio (ii) mechanical advantage (iii) efficiency, which is/are correct?
- A. (ii) only
  - B. (iii) only
  - C. (i) and (iii)
  - D. (ii) and (iii).
4. In which of the following is kinetic energy converted into potential energy?
- A. A car stops on level ground using its brakes.
  - B. A car runs at constant speed downhill using its brakes
  - C. A car runs downhill gathering speed
  - D. None of the above
5. A sample of water at  $0^{\circ}\text{C}$  and its density measured after each degree rise in temperature.
- A. Its density remains unchanged
  - B. Its density decreases steadily
  - C. Its density increases steadily
  - D. Its density increases for a while and then decreases
6. A balloon containing 546 ml of air is heated from  $0^{\circ}\text{C}$ . to  $10^{\circ}\text{C}$ . if the pressure is kept constant its volume at  $10^{\circ}\text{C}$  will be
- A. 546 ml
  - B. 556 ml
  - C. 566 ml
  - D. 576 ml
7. The coefficient of linear expansion of brass is approximately  $0.0000/^{\circ}\text{C}$ . therefore if  $1000\text{ mm}^3$  of brass is heated from  $0^{\circ}\text{C}$  it expands
- A.  $0.6\text{ mm}^3$
  - B.  $0.2\text{ mm}^3$
  - C.  $1.8\text{ mm}^3$
  - D.  $0.06\text{ mm}^3$
8. Provided the pressure is kept constant, the temperature to which 3 litres of gas at  $27^{\circ}\text{C}$  must be raised in order to increase its volume to 4 litres is
- A.  $36^{\circ}\text{C}$
  - B.  $78^{\circ}\text{C}$
  - C.  $127^{\circ}\text{C}$
  - D.  $400^{\circ}\text{C}$
9. If the speed at which a machine is operating is doubled and the force the machine exerts on an object is also doubled, then the power at which the machine is operating
- A. Is decreased
  - B. Remains the same
  - C. Is doubled
  - D. Becomes four times as great.

10. Which of the following liquids would be most suitable for use as a refrigerant in the domestic refrigerator?
- A. Ammonia
  - B. Water
  - C. Brine
  - D. Kerosene
11. The main reason that foods are cooked faster in a pressure cooker than in a pot is that,
- A. less heat escapes
  - B. the boiling point of the water is raised
  - C. they are not affected by the breeze
  - D. the vapour pressure is constant
12. 20 g of ice at  $-5^{\circ}\text{C}$  are converted into water at  $50^{\circ}\text{C}$ . if the specific latent heat of ice is  $336 \text{ J/g}^{\circ}\text{C}$ , the amount of heat necessary to do this is
- A. 4410 J
  - B. 4746 J
  - C. 11,130 J
  - D. 14,470 J
13. 150 g of a metal when cooled through  $10^{\circ}\text{C}$  will give out enough heat to raise the temperature of 30 g of water by  $5^{\circ}\text{C}$ . the specific heat capacity of the metal is therefore (Specific heat capacity of water =  $4200 \text{ J/kg}^{\circ}\text{C}$ )
- A.  $420 \text{ J/kg}^{\circ}\text{C}$
  - B.  $4200 \text{ J/kg}^{\circ}\text{C}$
  - C.  $150 \text{ J/kg}^{\circ}\text{C}$
  - D. None of these
14. Two simple barometers X and Y have 1ml and 2ml respectively of water introduced into the tubes. After few minutes the height of mercury in each barometer is read. It is found that the height of mercury is
- A. Unchanged
  - B. Significantly lower in Y than in X
  - C. Significantly lower in X than in Y
  - D. Lower and approximately equal in both
15. The instrument used for measuring the dew point is called a
- A. Wet and dry bulb hygrometer
  - B. Dewar flask
  - C. Renault's hygrometer
  - D. Radio sonde
16. 16.8g of a metal, whose specific heat capacity is  $400 \text{ J/kg}^{\circ}\text{C}$ , was heated to  $100^{\circ}\text{C}$  and then placed in a hollow in a block of ice at  $0^{\circ}\text{C}$ . the amount of water produced was (Specific latent heat of ice =  $336 \text{ J/g}$ )
- A. 2.0 g
  - B. 1.68 g
  - C. 671 g
  - D. None of these

17. A domestic refrigerator is cooled because

- A. Cold air is pumped through it
- B. A cold liquid is pumped through the coils around the freezing box
- C. Heat is taken from the air to evaporate the freezing liquid
- D. The ice in the refrigerator cools the air

18. When 30 g of methylated spirit whose temperature was 60°C was mixed with 32 of water, contained in a calorimeter of negligible heat capacity, the temperature of the water and calorimeter was raised from 30°C to 40°C. If we neglect the heat loss then the specific heat capacity of the methylated spirit was

- A. 1120 J/kg °C
- B. 4480 J/kg °C
- C. 2240 J/kg °C
- D. none of these.

19. Which of the following sets of conditions would be most suitable for the formation of dew?

- A. A clear calm night on cement
- B. A cloudy calm night on cement
- C. A clear windy night on grass
- D. A clear calm night on grass

20. Which of the following conditions would be most suitable for the formation of snow?

- A. A dew point below 0°C
- B. A region of high barometric pressure
- C. Raindrops falling on a frozen ground
- D. A very dry cold day