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Physics Learning Through 5E Model of Instructions: An Experimental Study

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***Abstract*:** In today's teaching and learning process, the 5E model of learning is seen as a good way to teach science. But there have not been many studies on it yet in the area of the study. So, this study was undertaken to look at how well the 5E model of leaning works compared to the traditional way of teaching in 9th-grade Physics. In this regard, a null hypothesis was tested using ANCOVA, and significance level at $p< 0.05$ was set. The study nature was experimental, and purposive sampling technique was used. The study used a group of 72 students from Peshawar, equally divided into two groups: one taught with traditional methods and the other with the 5E model. Both groups took a test before and after the treatment / teaching to measure / see how much they learned and assessed them in the form of test scores. The results exposed that the group taught with the 5E model significantly performed better. This means the 5E model helps students learn Physics better than traditional teaching methods. So, it was found that overall, the 5E model is a good way for teachers to teach. It helps students learn more and makes teaching more organized. It is recommended that teachers need to develop an environment and implement constructivist learning within the classroom. To achieve this, teachers should provide in-service training on the 5E model of learning. Thus teachers should learn about the 5E model to make their teaching better.

Keywords: 5E instructional design model, Learning, Traditional method, Physics, Experimental study, Teacher made test

1. Introduction

Competition in today's world is complicated without good education in technology and science. Physics is important for progress in many areas of life. We need better ways to teach students Physics so they have a good scientific base / and reasoning. Teaching methods have changed a lot, becoming more specific and professional. In the 21st century, teaching affects many parts of life like politics, culture, and economics etc. There is a connection between working and being a citizen. We wonder why we have not benefited more from classroom lessons. That is one reason for this research. In this study, a new teaching model for Physics/science was tested. We compared the 5E model with traditional lectures to see its effects. We looked at how the 5E model affects Physics learning and its impact on real-life.

According to RU Khan & HM Inam (2018), many things/factors can affect how students learn better. One big factor is how teachers teach. In Pakistan, studies have looked at how students learn physics/science. Teaching

Physics can be hard in many developing countries. Inappropriate teaching methods can make learners do/perform poorly in Physics. Many teachers and students donot use helpful teaching techniques that could help them understand scientific ideas better (Abimbola, 2013). Using different teaching strategies can make students more interested in science/physics and do better (Ajaja, 2013). Also, teachers who understand teaching skills ofscience well can use new and active teaching methods effectively (Oyelekan & Olorundare, 2015). In Pakistan, having good scientific education, using better teaching methods, not just memorizing facts, and having tools to teach science are all important for Physics (Halai, 2008). Only when teachers are ready to try new things and there's a good curriculum can science in general in general, especially Physics, be taught effectively

In this present study, selected the 5E model for teaching founded on learning theory of constructivism, because it is good for science subjects, gives clear results, and can be used in both school and everyday life. Roger Bybee created it in the 1980s, and it's about students working together to solve problems and learn new things by asking questions, observing, and drawing conclusions. There are five main parts: Engagement, Explanation, Exploration, Elaboration, and Evaluation. Students start by being active, then the teacher guides them through group activities to understand and apply new ideas, and finally, they evaluate what they've learned. According to Orgill, M.K. & Thomas, and M. (2007), researches show that students learn better when they understand deeply and are curious, and they often follow the footsteps of previous students in learning new concepts. In the Engagement phase, students connect what they already know to what they're learning. In Exploration, they figure out the main ideas and how they work. Then, in Explanation, they focus on one idea, while the teacher helps them understand it better. In Elaboration, they get to practice and expand on what they've learned. Finally, in Evaluation, they're tested on what they've learned. This study looks at how using the 5E model can help students learn Physics better in secondary school and improve their test scores.

1.2 Problem Statement

In today's education, teaching and learning is different from before, as now it is becoming more specialized and professional. In the 21st century, how people work and their different roles in society are influenced by education. This means there is a connection between work and being a citizen. We might wonder why classroom teaching is not as effective as it could be. This question led to more research in this area. Physics is important because it helps us progress in science and technology. But teaching Physics with the traditional way makes students lose interest and do poorly in school and do not pursue further education in Physics. They find it boring and irrelevant. To make Physics interesting and effective, it was needed to use the 5E Model for teaching and learning. That is why this study was undertaken and done.

1.3 Contribution to the Literature

The envisaged research reveals that some studies have been conducted in the field, particularly from the perspective of our society, the environment, and educational institutions. Additionally, no relevant study is available in this specific area of specialization. Moreover, there are gaps in the conducted studies and questions that need to be answered regarding the subject of the study. Therefore, the current research aims to address several gaps and thus make significant contributions to existing knowledge and literature. This research will hopefully be beneficial for students, educators, educational planners, and curriculum designers. It is truly important for the improvement of educational institutions, the system of education, and community as a whole, parents, and policymakers of the country. It will also be useful in other communities worldwide. Consequently, it would open new perspectives and contribute significantly to existing knowledge. The researched study has suggested some important ethics for upcoming researches. Therefore, it can serve as a source of inspiration and guide for future investigators to look at additional aspects of the present study and lay a foundation for future research.

1.4 Research Objectives

The objectives of the study were:

a) To calculate the students test scores by conducting traditional method of teaching and 5E model of teaching in the Physics subject at the Class-9th level.

b) To assess students' achievements in the Physics subject through the application of the 5E model for teaching/learning purposes at the ninth-grade level.
c) To propose recommendations for enhancing the current teaching methodologies of Physics subjects.

1.5 Hypothesis

In light of the above objectives, the subsequent null hypothesis was tested:

H_{01}: There is no major effect of 5 E Model of Instructions on students' achievement in the Physics subject at the Class-9 level.

1.6 Significance of the Study

This research is really helpful for teachers, parents, school leaders, society, and people who make rules because; teachers who teach Physics can learn new ways to teach better from this study, this information can help make changes in schools to make education better and Policymakers can use the results to plan how to help teachers get better at teaching, especially in Physics and other science classes in general.

2. Literature Review

In today's fast-paced world, traditional education systems are increasingly challenged to adapt to the demands of the 21st century. The concept of 21st century learning skills has emerged as a response to these challenges, emphasizing the need for a change in educational practices to better prepare students for success in the modern world. The skills of the 21st century are defined as a set of abilities that learners need to enhance and thus help him to succeed in the digital age of global village. These skills are often categorized into four main categories:

a) Critical Thinking and Problem Solving: This entails the ability to scrutinize information, assess arguments, and devise inventive solutions to intricate problems. According to Partnership for 21st Century Learning(P21), skills of solving problems and thinking critically are indispensable skills for flourishing in the 21st century (P21, 2009).
b) Communication: skills of Effective communication are necessary in today's interrelated/unified world. This encompasses the capability to convey thoughts clearly and convincingly, both orally and in written form, along with the ability to collaborate with others (P21, 2009).
c) Collaboration and Teamwork: In today's global economy, the capacity to function efficiently within teams is indispensable. Collaboration and teamwork skills entail the ability to collaborate harmoniously with others, appreciate diverse viewpoints, and contribute to a common objective (P21, 2009).
d) Creativity and Innovation: Creativity and innovation are recognized as catalysts for economic growth and advancement. These skills encompass the capacity to think creatively, generate fresh ideas, and employ them in inventive ways (P21, 2009).

In the 5E model, as narrated in the Journal of Education and Training Studies: Vol.3, No.6; 2015, learners can comprehend and interpret the topic independently, thus making the learning process meaningful and enduring. Numerous studies have emphasized the importance of 21st century learning skills in education. For instance, a study by Trilling and Fadel (2009) revealed that skills like critical thinking, collaboration, and communication were crucial for success in the contemporary workplace. Similarly, research by Griffin and Care (2015) indicated that students who acquired 21st-century skills exhibited higher academic performance and increased engagement in learning. Teaching models play a vital role in education by providing a structure for designing, delivering, and evaluating instruction. These models assist educators in organizing their teaching methods, strategies, and resources to facilitate effective learning. Studies have demonstrated that well-designed teaching models can positively impact student learning outcomes. For example, research by Hattie (2009) demonstrated that models such as direct instruction and cooperative learning significantly improved student achievement. Likewise, a meta-analysis conducted by Slavin (2014) revealed that inquiry-based learning models had a favorable effect on student learning across various subject areas.

Traditional teaching featured by teacher-centered teaching and rote-memorization, have been the mainstay of education for centuries. However, in the 21st century, there is a growing recognition of the need to shift towards more student-centered, inquiry-based approaches that foster 21st century learning skills. Research has shown that traditional teaching methods may not adequately train learners for the requirements of the 21st century. For example, a study by P21 (Partnership for 21st Century Skills) found that traditional teaching methods often do not sufficiently widen skills of communication, creativity, critical thinking and collaboration (P21, 2009). Another study by Wagner (2012) highlighted the importance of 21st century skills such as adaptability, curiosity, and entrepreneurial spirit, which may not be fostered in traditional classrooms. Traditional methods of teaching science subjects at the school level have been used for many years, typically involving lectures, textbook readings, and rote memorization. Traditional teaching methods in science education often focus on transmitting factual information and may involve the following:

a) Lectures: Teachers deliver content through lectures, often using slides or chalkboards to present information.
b) Textbook Readings: Students are assigned readings from textbooks to learn key concepts and principles.
c) Rote Memorization: Students may be required to memorize facts, formulas, and definitions without necessarily understanding the underlying concepts.
d) Experiments and Demonstrations: While hands-on activities are part of science education, they are often used to illustrate concepts rather than as the primary mode of learning.

Research on the effectiveness of traditional methods for teaching science subjects has yielded mixed results. Some studies suggest that traditional methods can be effective in imparting factual knowledge and basic concepts (McKeachie, 2006). However, other studies indicate that traditional methods may not be as effective in promoting deeper understanding, critical thinking, and problem-solving skills (Prince & Felder, 2007). In main challenges of traditional teaching, one is that it often encourages inactive learning, where learners are anticipated to take up information rather than keenly engage with it (Hake, 1998). This can direct to surface-level learning and a lack of deep understanding of scientific concepts.

In response to the limitations of traditional methods, educators have explored alternative approaches to teaching science, such as the 5E model of teaching, which includes the stages of Engage/Explore/Explain/Elaborate, and Evaluate, has been widely applied in science education to support student-centered learning and inquiry-based instruction. This model has been widely used in science education but has also been applied to other subject areas. The Engage phase of the 5E model is designed to capture students' interest and stimulate their thinking. This phase sets the stage for the learning experience by presenting a question, problem, or scenario that piques students' curiosity. Research has shown that engaging students at the beginning of a lesson can increase their motivation and interest in learning (Hidi & Renninger, 2006). The Explore phase encourages students to investigate concepts, ideas, and materials through hands-on activities and experimentation. This phase promotes active learning and allows learners to enlarge skills of critical thinking, solving problems and collaboration (Kolb, 1984). Research has shown that hands-on, experiential learning can enhance student understanding and retention of concepts (Prince & Felder, 2007). In the Explain phase, teachers provide explanations, demonstrations, and discussions to help students make sense of their explorations. This phase emphasizes the importance of clear communication and conceptual understanding (Tobin, 1987). Research has shown that providing clear explanations and feedback can improve student learning outcomes (Hattie & Timperley, 2007). The Elaborate phase allows students to apply their understanding of concepts to new situations or problems. This phase encourages students to think critically, make connections, and transfer their learning to real-world contexts (Jonassen, 1997). Research has shown that applying knowledge to new situations can deepen understanding and improve retention (Bransford et al., 2000). The Evaluate phase involves assessing student learning to determine the effectiveness of the instructional activities. This phase allows teachers to gauge student understanding, identify areas for improvement, and provide feedback for future learning (Black & Wiliam, 1998). Research has shown that formative assessment can improve student learning outcomes (Hattie, 2009).

Research has publicized that the model of 5E can be highly useful for teaching science subjects at the school level. Like, a study of Bybee et al. (2006) found that the 5E model led to significant improvements in student understanding of scientific concepts and increased engagement in learning. Similarly, a meta-analysis by Linn et al. (2008) concluded that the 5E model was associated with positive student learning outcomes in science education.

Both the traditional teaching methods and the 5E model of teaching represent two distinct approaches to education, each with its own strengths and weaknesses. Traditional teaching methods, such as lectures, textbook readings, and rote memorization, have been the predominant approach to education for centuries. Some of the key merits include Efficiency: Traditional methods can be efficient for delivering information to a large group of students in a short amount of time. Familiarity: Traditional methods are familiar to both teachers and students, making them easy to implement. Structure: Traditional methods provide a clear structure for instruction, with defined roles for teachers and students. The demerits of traditional teaching methods include: Passive Learning: Traditional methods often support inactive learning, where learners are anticipated to take information rather than energetically engage with it. Lack of Engagement: Traditional methods may not effectively engage students or stimulate their curiosity and interest in learning. Limited Application: Traditional methods may focus on memorization of facts and formulas rather than promoting deeper understanding and critical thinking skills.

On the other hand, the 5E model of teaching is an inquiry-based approach that aims to promote active learning and deeper understanding. Some of the key merits include: Active Learning: The 5E model promotes active learning, where students are actively engaged in exploring concepts and solving problems. Deep Understanding: The 5E model encourages students to develop a deeper understanding of concepts by engaging in hands-on activities and inquiry-based learning. Critical Thinking: The 5E model helps develop students' critical thinking and problem-solving skills by encouraging them to ask questions and seek answers through investigation. The demerits of the 5E model of teaching include: Time-Consuming: Implementing the 5E model can be time-consuming, as it involves planning and facilitating hands-on activities and inquiry-based learning experiences. Resource-Intensive: The 5E model may require additional resources, such as materials for experiments and activities, which may not be readily available in all educational settings. Teacher Training: Implementing the 5E model effectively may require additional training and support for teachers to shift from traditional methods to inquiry-based instruction.

When we look at how well the 5E model and traditional teaching methods work, we need to think about a few things. People like the 5E model because it helps students think and solve problems better, which is important in today's busy world. But sometimes, traditional methods might be better, especially when we have to teach a lot of things quickly.

In conclusion, both traditional teaching methods and the 5E model of teaching have good and bad points. Traditional methods are quick and familiar, but they might not help students to learn actively or think critically. On the other hand, the 5E model makes learning more active and helps students understand better. But it might need more time, money, and training to use properly. Teachers should think about what they want to achieve with their teaching and pick the method that fits their goals the best.

3. Research Methodology

It was an experimental study. A teacher made test in the subject of Physics (consists of 40 Objective type: MCQs) attached as Appendix-A to this paper was designed and validated to measure students' Physics learning in the form of test scores/results. Before the intervention/treatment, conducted pre-test and calculated the initial scores of control and experimental groups. After treatment of both groups, conducted a post test to compare the results of both control and experimental groups and measure the effectiveness of the treatment.

3.1 Research Design

It was an experimental study design, which was used to find the effectiveness of 5 E model of learning. Researcher used a method called ANCOVA, which combines ANOVA and regression analysis. ANCOVA helps compare two sets of data that have two variables (treatment and effect), with a third variable called the "covariate." Adding a covariate to any ANOVA design turns it into an ANCOVA design. Using a covariate helps make groups more equal on one or more variables, which increases the correctness of the results. In the study, it was needed to account for the effect of the pre-test score to see the real differences in physics achievement/scores of both groups i.e experimental and control. The post-test score was the thing we measured, while the control and experimental groups were the things we compared. The pre-test result/score was regarded a covariate variable.

3.2 Research Tools / Instruments

An achievement teacher made test in the subject of class-9th Physics was applied for collection the data. A teacher made test was framed from the three chapters of the Physics text book of class-9th level approved by the federal government Islamabad. Total forty objective-type test items included in the teacher made test, all were based on MCQs(multiple-choice questions).

3.3 Population / Sample of the Study

Population was the all schools and learners of class-9th form Peshawar city, KPK. Purposive sampling technique was used and total 72 students randomly selected from four different sections of the schools in Peshawar city of KPK. To control the intervening variables, individual difference were kept up to minimum. So, all male students between the age of 13 to 15 years and were physically fit and mentally well were taken as a sample. These 72 pupils were randomly separated into two groups; one was control group=36 students and the second was experimental group=36 students.

3.4 Procedure of the Study

A teacher created a Physics test for students and experts of the field checked it for validity and made sure it was good. Then, students in two groups took a pre-test before treatment/learning. Both groups studied the same chapters, but one group learned with a new method (5 E model of learning) while the other learned in the usual/traditional way. Each group was taught 03 chapters/had total 12 classes and each class of 40 minutes. Researchers made sure the test was fair/valid. After finishing the chapters, both groups took another post-test. The results of both groups were calculated, tabulated and compared.

4. Data Analysis

Data analysis involved both descriptive and inferential statistics. The main statistical test used was Analysis of Covariance (ANCOVA), which helps control the effect of the pre-test score. We used MS-Word, MS-Excel, and SPSS software for writing, organizing data, and analysis. The data were tabulated and analyzed using SPSS version-27, with a significance level set at $p < 0.05$. Findings were then interpreted, and conclusions were drawn based on the research results.

4.1 Findings/Results of the Research

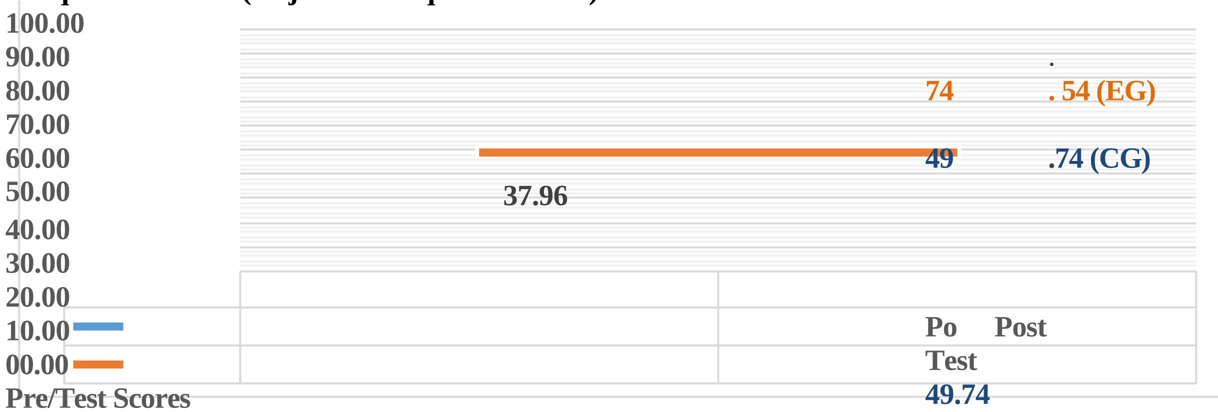
A method called ANCOVA was used to compare traditional teaching methods and the 5E model of teaching after partially-out student pre-test scores. This method looks at the difference between two groups while considering students' pre-test scores. Before we looked at the data, we checked if certain things were true, like if the groups were similar and if the data was normal. Everything looked good. We also checked if there was a relationship between the pre test and post test scores/results, which is important for ANCOVA. The results are shown in the table/figure below.

4.2 Tests of Between-Subjects Effects

Table 1: Dependent Variable Post Test

Source	Type-III Sum of Squares	df	Mean-Square	F	Sig.	Partial-Eta Squared
Intercept	6278.49	1	6268.49	179.30	<0.01	0.74
Pre-test	143.94	1	143.84	4.09	<0.05	0.06
Group	10655.70	1	10655.70	302.50	<0.01	0.83
Error	2369.32	68	35.31			
Total	300656.00	71				
Corrected Total	13176.49	70				

R-Squared=0.831 (Adjusted R Squared=0.827)



Pre/Test Scores **49.74**
1.Control Group(CG) 37.94 **74.54**
2. Experimental Group(EG) 37..88

Table/Figure: Achievement Test Mean Scores of Pre test and Post test of both groups (Exp& Control)

The information in the table/figure above depicted that there was a big difference in how well students did in their achievements between those taught with traditional methods and those taught with the 5E Model of Instructions, F(2, 67)=153.47, p<.001 η2 =0.83. Hence, rejected the null hypothesis. It revealed that 5 E model of instructions has affected significantly students achievement scores in Physics subject.

4.3 Discussion

The reason behind research was to evaluate the effectiveness of the 5 E model on learners performance in subject of Physics at secondary level. An experimental approach was employed to compare the achievements of a control group, taught using traditional lecture methods, with those of an experimental group exposed to the 5 E instructional model. The findings indicated that 83% of the variance in Physics achievement scores could be attributed to the use of the 5 E instructional model. Therefore, the null hypothesis of the research that 5 E model of learning has no significant effects on students achievement was rejected. Furthermore, previous literature and studies in the field also supported the notion that students in the experimental group demonstrated greater engagement and higher test scores. This study, conducted within a single district with a limited sample size, had notable limitations, including its focus solely on 9th-grade Physics students and testing from only three chapters of the textbook. However, despite these constraints, the study offered valuable insights for educators, parents, school administrators, and policymakers. It highlighted the potential benefits of adopting interactive and activity-based teaching methods like the 5 E instructional model in Physics education at the secondary level, challenging the traditional reliance on lectures and teacher-centered approaches in Pakistani schools. The study recommended further exploration and implementation of innovative teaching methodologies to enhance student engagement and learning outcomes in Physics.

5. Conclusions

In the contemporary age of 21st century characterized by modernization and the rise of innovative approaches to education, assessing educational effectiveness often hinges on the outcomes and accomplishments of students in various subject areas. Among these, the performance in Physics holds particular significance to educational policymakers due to its role in imparting fundamental concepts, rules, and principles crucial for a technologically advancing society. This research provides concrete evidence to endorse instructional strategies based on the 5 E model in teaching Physics at the secondary level. The implications of these findings are valuable for Physics educators seeking to refine their teaching methodologies and better prepare their students for the subject.

5.1 Study Recommendations / Future Research

The study investigated the effectiveness of the 5 E learning model on students' Physics performance and concluded that it significantly improved their achievements / test scores. Consequently, it is recommended that secondary school teachers adopt the 5 E learning model. There should be a focus on incorporating interactive and activity-based approaches, and professional development opportunities such as refresher courses should be provided within teacher education programs. This will enable teachers to become familiar with other interactive teaching methodologies based on the 5 E instructional model. Additionally, further research could explore the usefulness of the 5 E learning model compared to traditional teaching across various grade levels and different other science subjects.

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Appendix A: Distribution of Test Items (Physics: Class-09)

Test Items: 40 MCQs   Marks: 40   Duration: 50 Minutes

Chapter	Total Items	Distribution of Items / Marks		
		Knowledge	Compre-hension	Applic-ation
1. Simple Harmonic Motion & Waves	20	7	7	6
2. Sound	10	4	3	3
3. Basic Electronics	10	4	3	3
Total Test Items	**40**	**15**	**13**	**12**

Appendix B: Researcher Made : PAT (Physics Achievement Test)

(Pre Test / Post Test)

Student Name.____________________________________ Roll No.__________
School Name. ____________________________________ Subject. Physics Gender. Male
Class. 09

Total Time. 50 Minutes Total Marks. 40

Marks Obtained: -------- / 40

Instructions: Four possible answers are given to each of the following statements. Read each question carefully and encircle the correct answer from the given options. Each question has one mark. Overwriting or deleting or encircling more than one option is not allowed.

1. The time period of a simple pendulum depends on:
   a. Mass of the pendulum b. Amplitude of the oscillation
   c. Length of the pendulum d. All of the above
2. What is the defining characteristic of simple harmonic motion?
   a. Constant velocity b. Constant acceleration c. Constant speed d. Constant displacement
3. The maximum displacement from the equilibrium position in simple harmonic motion is called:
   a. Frequency b. Amplitude c. Wavelength d. Period
4. In simple harmonic motion, the restoring force is directly proportional to:
   a. Velocity b. Displacement c. Acceleration d. Mass
5. The SI unit of frequency is:
   a. Hertz b. Newton c. Joule d. Watt
6. In simple harmonic motion, the maximum speed occurs at:
   a. Maximum displacement b. Equilibrium position
   c. Midway between equilibrium and maximum displacement d. Minimum displacement
7. The formula for the frequency (f) of a wave is:
   a. $f = T/\lambda$ b. $f = \lambda/T$ c. $f = A/\lambda$ d. $f = \lambda/A$
8. Which type of wave requires a medium for propagation?
   a. Transverse wave b. Longitudinal wave c. Electromagnetic wave d. Standing wave
9. The speed of a wave is determined by the product of its:
   a. Frequency and wavelength b. Amplitude and period c. Velocity and acceleration
   d. Mass and displacement
10. The phenomenon of interference is associated with:
    a. Reflection b. Refraction c. Diffraction d. Superposition
11. The pitch of a sound wave is most closely related to its:
    a. Frequency b. Amplitude c. Wavelength d. Speed
12. A wave with a frequency of 10 Hz and a wavelength of 2 m has a speed of:
    a. 5 m/s b. 10 m/s c. 20 m/s d. 2 m/s
13. What is the unit of wavelength?
    a. Hertz b. Meter c. Second d. Joule
14. The phenomenon of resonance is most noticeable when:
    a. Forces are in the same direction b. Frequencies match
    c. Wavelengths are different d. Amplitudes are minimal
15. An example of a transverse wave is:
    a. Sound wave b. Light wave c. Longitudinal wave d. Water wave
16. The speed of light is fastest in:
    a. Vacuum b. Air c. Water d. Steel
17. The number of oscillations per unit time is known as:
    a. Amplitude b. Frequency c. Wavelength d. Period
18. The unit of amplitude is:
    a. Hertz b. Meter c. Second d. Joule
19. In a longitudinal wave, the particles of the medium move:
    a. Parallel to the direction of the wave b. Perpendicular to the direction of the wave
    c. In circular paths d. In random directions

20. The distance between two consecutive compressions or rarefactions in a longitudinal wave is called:
a. Wavelength b. Amplitude c. Frequency d. Period
21. What type of wave is sound?
a. Transverse b. Longitudinal c. Electromagnetic d. Standing
22. The speed of sound is maximum in:
a. Air b. Water c. Vacuum d. Steel
23. The frequency of a sound wave determines its:
a. Loudness b. Pitch c. Quality d. Amplitude
24. Which part of the ear amplifies sound vibrations?
a. Cochlea b. Eardrum c. Hammer d. Auditory nerve
25. The unit of measurement for the intensity of sound is:
a. Decibel b. Hertz c. Watt d. Ampere
26. Sound travels faster in:
a. Cold air b. Hot air c. Humid air d. Dry air
27. Which material is a good conductor of sound?
a. Rubber b. Wood c. Glass d. Metal
28. What is the speed of sound in air at room temperature (approximately)?
a. 343 m/s b. 1500 m/s c. 0 m/s d. 300,000,000 m/s
29. The phenomenon of the persistence of sound after the source has stopped is known as:
a. Refraction b. Reflection c. Reverberation d. Diffraction
30. Which part of the ear is responsible for maintaining balance?
a. Cochlea b. Vestibule c. Eardrum d. Auditory nerve
31. What does LED stand for?
a. Light Emitting Diode b. Long Electrical Device c. Low Energy Detector
d. Loud Electronic Drum
32. In a circuit, the component that stores electrical energy is called:
a. Resistor b. Capacitor c. Inductor d. Diode
33. What is the basic unit of electrical resistance?
a. Watt b. Volt c. Ohm d. Ampere
34. Which of the following is a semiconductor material?
a. Copper b. Aluminum c. Silicon d. Iron
35. A device that allows the flow of current in one direction only is called:
a. Resistor b. Diode c. Transistor d. Capacitor
36. The flow of electric current is measured in:
a. Watts b. Volts c. Amperes d. Ohms
37. What is the purpose of a resistor in an electronic circuit?
a. To store energy b. To control current c. To amplify signals d. To generate light
38. Which electronic component amplifies or increases the strength of an electrical signal?
a. Capacitor b. Resistor c. Transistor d. Diode
39. What does AC stand for in the context of electrical power?
a. Alternating Current b. Average Current c. Amplified Current d. Analog Current
40. The combination of two or more electronic components forms a:
a. Circuit b. System c. Device d. Module

Appendix C: Key to Correct Answers

1. c. Length of the pendulum 2. b. Constant acceleration 3. b. Amplitude
4. b. Displacement 5. a. Hertz 6. b. Equilibrium position 7. b. $f = \lambda/T$
8. b. Longitudinal wave 9. a. Frequency and wavelength 10. d. Superposition
11. a. Frequency 12. a. 5 m/s 13. b. Meter 14. b. Frequencies match

15. b. Light wave 16. a. Vacuum 17. b. Frequency 18. b. Meter
19. a. Parallel to the direction of the wave 20. a. Wavelength 21 b. Longitudinal
22 d. Steel 23 b. Pitch 24 c. Hammer 25 a. Decibel 26 b. Hot air
27 d. Metal 28 a. 343 m/s 29 c. Reverberation 30 b. Vestibule 31 a. Light Emitting Diode
32 b. Capacitor 33 c. Ohm 34 c. Silicon 35 b. Diode 36 c. Amperes
37 b. To control current 38 c. Transistor 39 a. Alternating Current 40 a. Circuit