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Difficulties in wave's motion in the Physics curriculum in secondary schools: Students' and teachers' view

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Abstract
This study investigated the view of physics teachers and students in difficult topics and concepts in waves theme in the curriculum of Physics in secondary schools in Ife North Local Government Area of Osun State, Nigeria. Specifically, it sought to determine difficult topics and abstract concept in wave theme from students' perception and to examine the likely reasons for difficulty in wave's concept from students and teachers perception. Descriptive survey research design was considered appropriate for the study. The study population comprised 310 physics students and 15 physics. The sample consists of 180 Physics students selected though simple random technique and 6 Physics teachers selected purposively. Two instruments were used for this study, the first instrument was meant for students to address three research questions while the second instrument meant for the teachers addressed one research question The instruments were validated by two experts to ascertain face and content validity. The data was analyzed using Relative Strength Index (RSI). The results of the findings study showed that mathematical complexity, excessive formulas, and limited practical demonstrations are the main reasons for experiencing difficulty in wave's motion. It was recommended among others that the outcome of research like this should be made available to stakeholders.

Keywords: Difficulties, waves theme, curriculum, physics Students' view, Teachers' view

Introduction

Physics subject in secondary schools has recorded low enrolments over the years compared to other science subjects. Besides, from the few physics students that enrolled and sit for external examinations in Nigeria, the performance of them has been unsatisfactory. The continuous and recurring abysmal performance and attitude have made stakeholders especially researchers in science education craving for solution to improve the learning outcomes in Physics. From the view of students, the idea that physics is very hard compared to Biology, Chemistry and other sciences has been on saying. The WAEC and NECO performance report consistently indicate that Physics has been recording lower credit-level passes in comparison to Chemistry and Biology subjects (WAEC, 2022; NECO, 2022) [19]. Students often face significant challenges in learning of Physics, particularly when it comes to abstract and difficult concepts (Ajayi & Balogun, 2017) [3]. The learning outcomes and students' perception are not unconnected with the reason why Physics and allied courses have low entrants in higher institutions. In Nigeria universities for example, physics department and the unit of Physics in Teacher Education continue to witness paucity of students, which is the reason for serious shortage of physics teachers in secondary schools (Erinosho, 2013) [9]. So far, the importance and relevance of the subject need to be constantly rekindled both on the minds of the students and the teachers as well in their focus.

One of the most fundamental sciences that directly advance the course of technologies is Physics. This means that Physics plays a central role in the evolution of our modern-day technology. Physics is concerned with the acquisition of knowledge on the relationship between energy and matter (Nduji, 2019) [17]. Physics is an exciting intellectual adventure that inspires young people and expands their frontiers of knowledge about energy, matter and their interactions (Shahid, 2020) [18].The contents in the themes of Physics curriculum are practically, mathematically conceptual and theoretically inclined that demand positive attitude, self-efficacy and metacognitive skills of students. These however further demand that a credit pass in Physics is a requirement for entry into higher institutions for further study in science, engineering, aviation, astronomy and medicine. Besides, the knowledge of Physics is demanded for courses like telecommunication, medicines, and computer science and skills learnt from those courses can boost individuals' economy and national development (Taangahar & Okwori, 2022) [19].

Following the thematic approach in the orgsnisation of Physics curriculum, thus it provides the students with a deep understanding of the natural world and the principles that govern it which enables physics education to play a crucial role in the development of scientific processes and values among secondary school students. These lay credence to the general objectives of Physics. The general objectives of physics teaching are to provide basic knowledge in Physics for functional living, acquire rudimentary concepts and principles of Physics as preparation for further studies, and to acquire essential scientific skills and attitudes for technological application, and stimulate creativity (Nigerian Educational Research and Development Council, NERDC, 2008) [21]. From the focus objectives of physics curriculum,

the knowledge of Physics is a pillar for human survival with reference to scientifically and technological development, so, therefore the contents in physics curriculum must be explicit to both teachers and students. The current physics curriculum has been reformed from the conceptual approach to the thematic approach. The thematic approach of the new curriculum is to ensure compliance with national and global issues and ensuring sustainable development. The six themes which have related topics and contents in the curriculum are:

1. Interaction of matter, space and time
2. Conservation principles
3. Waves: Motion without material transfer
4. Fields at rest and in motion
5. Energy Quantization and Duality of matter.
6. Physics in Technology

All these themes are important, but there is a need to look at a closer look at the wave theme, for the fact that most information about our surroundings comes to us in form of waves. Waves is very important in transferring signals to human senses, humans ears are receiving signal from sound waves, and humans eyes are receiving signal through to eyes. Waves is a fundamental theme in Physics, encompassing a wide range of physical phenomena such as the periodic motion in a swing in motion, a vibrating tuning fork, the movement of earth in its orbit around the sun and the motion of a simple pendulum. Other physical quantities in which we can study waves include motion of needle of sewing machine, waves-motion on wiggling rope.

The usefulness and application of wave's concept are so germane to activities of life. The concepts and principles in waves could be abstract and difficult to comprehend by students if not properly disseminated. This is because most students perceive physics as a subject with abstract concepts (Ugwuanyi, 2012) [10] like waves concepts. Students' perception of concepts could refer to how they view, observe or consider such concepts. The perception process essentially involves sensory stimulation and selection, organization as well as interpretation. This process automatically occurs in an individual's cognitive structure. Thus, the extent to which students perceive a concept as difficult or not, largely depends on the manner it is taught and the performance of the students (Taangahar & Okwori, 2022) [19]. The abstract nature of the concepts poses a significant barrier to effective teaching and learning, as students struggle to develop a deep understanding and make meaningful connections to other related themes (Olayiwola & Adebayo, 2021). However, both teachers and students often face significant challenges in the teaching and learning of Physics, particularly when it comes to abstract and difficult concepts (Ajayi & Balogun, 2017) [3]

Despite the objectives of Physics and the way it is structured, students' views about topics in Physics are not encouraging. According to Shiwani (2022) [19], many students are challenged with difficulties in understanding physics concepts due to demands in problem-solving skills from the students. According to Nava and Camarao (2017) [3], students perceive that teaching, which emphasises more on solving problems, was a major source of difficulty for them. Some students consider some concepts in Physics as difficult due to many formulae and laws and too much calculations with little practical work (Bello, Opaleye and Olatunde, 2018) [5] while Physics is a subject that requires high numerical literacy (Taangahar & Okwori, 2022) [19].

Difficult concepts are concepts that are abstract in nature and also not easily comprehended to teach and learn. This is evidence in declining in number of students who opted for physics as a course of study in higher institutions (Aina, 2018) [2]. The challenge of students in understanding Physics concepts is seen as a global challenge (Bello, Opaleye and Olatunde, 2018) [5]. Waves concepts are characterized with mathematical concepts and limited availability of practical resources for demonstration in the classroom which could pose problem for students' compression. The perceived difficulty in waves theme could be attributed to factors such as lack of real-world applications, mathematical complexity, and limited availability of appropriate teaching resources (Balogun & Ajayi, 2019). The importance of a collaborative approach between teachers and curriculum developers to address the challenges associated with teaching and learning abstract and difficult physics concepts can never be over emphasized in waves theme. Given the critical role of physics education in the overall development of students and the persistent challenges faced by both teachers and students. it is essential to conduct a comprehensive assessment of the abstract concepts and difficult topics in the senior secondary school physics curriculum in relation to waves concepts as the focus of this study.

Statement of problem

Studies have shown that both teachers and students in senior secondary schools (SSS) in Nigeria often face significant challenges in the teaching and learning of Physics particularly when it comes to abstract concepts and difficult topics. The perceived difficult topics and abstract concepts could the reason for unimpressive learning outcomes in Physics. Although literature explain that students encountered difficulty in learning Physics because of Mathematics demands and lack of practical exposure but these have not been traced to a particular theme in Physics curriculum at the secondary schools. Among the themes in Physics curriculum, wave's concepts are more demanding in terms of coverage, immediate applications and the need of practical sessions. Thus, there is a need for investigation on view of students and teachers view on difficulties in waves theme in the curriculum of Physics in secondary school to give direction in this aspect of Physics subject.

Purpose of the Study

The study investigated the difficulties in waves theme in the curriculum of physics in secondary schools: students' and teachers' view.

The specific objectives of the study are to:

1. Determine difficult topics in waves in the curriculum of Physics in secondary schools from students' perception.
2. Determine abstract concepts in waves in the curriculum of Physics in secondary schools from students' perception.

Examine the likely reasons for difficulty in wave's concept in senior secondary Physics from students and teachers perception.

Research Questions

The following research questions guided the study:

1. What are the difficult topics in waves in the curriculum of Physics in secondary schools from students' perception?
2. What are the abstract concepts in waves in the curriculum of Physics in secondary schools from students' perception?
3. What are the likely reasons for difficulty in wave's concept in senior secondary Physics from students' perception?
4. What are the likely reasons for difficulty in wave's concept in senior secondary Physics from teachers' perception?

Research Hypothesis

The hypothesis tested in the study:

There is no significant difference between teachers' and students' perception on likely reasons for abstract concepts difficulty in waves at senior secondary Physics.

Methodology

The study considered descriptive survey research design appropriate as a blueprint to investigate difficulties in waves theme in the curriculum of Physics in secondary schools: students' and teachers' view. The study population comprised 310 physics students and 15 physics teacher in all the 15 secondary schools in Ife North Local Government Area of Osun State, Nigeria. Ten schools were purposively selected on the criteria of having physics teachers, sizeable number of students for the research and the schools having been producing students for the external examination for the past ten years. Ten schools meet up with these criteria and 18 students were selected through simple random technique from each senior secondary school three (SSS3) and 6 physics teachers purposively selected based on the fact that they are permanent teachers from the state teaching service commission. Two instruments were used for this study, the first instrument was meant for students, it consists of three sections, the first section sought for students perception towards difficult topics on the responses of Not Difficult (ND), Low Difficulty (LD), Moderately Difficult (MD) Highly Difficult (HD), Extremely Difficult (ED).The second section sought for difficult concepts in waves on the responses of likert-type five point scale of measurement of Not Abstract (NA), Low Abstract (LA), Moderately abstract (MA) , Highly abstract,(HA), Extremely Abstract (EA). The third section elicited likely reasons for abstract concepts difficulty in waves on likert-type of four point scale of measurement of Strongly Agree (SA), Agree (A), Disagree, and Strongly Disagree (SD).

The second instrument was meant for the teachers sought for likely reasons for abstract concepts difficulty in waves on likert-type of four point scale of measurement of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree. The instruments were validated to ascertain face and content validity by two experts, a secondary school Physics teacher who was an examiner with National Examination bodies for almost 15years ago and a physics educator from Department of Science Education in Obafemi Awolowo, University, Ile-Ife, Nigeria were used.

Results

Research Question One: What are the difficult topics in waves in the curriculum of Physics in secondary schools from students' perception?

To determine the difficult topics in waves in secondary school Physics curriculum from students' perception, the descriptive statistics of the responses of the students on 10-item of sub-topics in waves were analysed and presented in Table 1.

Table 1: Descriptive Statistics on Difficult Topics in Waves from Students' Perception in Secondary Schools.

S/N	Topics	Level of difficulty					$\bar{X}$	St. D	RSI	Rank
		ND	LD	MD	HD	ED				
1.	Wave Motion	95 (52.8)	39 (21.7)	30 (16.7)	6 (3.3)	10 (5.6)	1.87	1.14	9.36	10
2.	Classification of Waves	80 (44.4)	43 (23.9)	39 (21.7)	8 (4.4)	10 (5.6)	2.03	1.16	10.14	9
3.	Mathematical Representation of Waves	58 (32.2)	45 (25.0)	41 (22.8)	28 (15.6)	8 (4.4)	2.35	1.20	11.75	5
4.	Sources of Sound and Transmission of Sound Waves	48 (26.7)	69 (38.3)	30 (16.7)	21 (11.7)	12 (6.7)	2.33	1.18	11.67	6
5.	Vibration in a String	54 (30.0)	41 (22.8)	39 (21.7)	33 (18.3)	13 (7.2)	2.50	1.28	12.50	3
6.	Types of Musical Instruments	70 (38.9)	50 (27.8)	32 (17.8)	21 (11.7)	7 (3.9)	2.14	1.17	10.69	8
7.	Dispersion of white light	47 (26.1)	48 (26.7)	38 (21.1)	36 (20.0)	11 (6.1)	2.53	1.24	12.67	2
8.	Electromagnetic Wave	62 (34.4)	45 (25.0)	39 (21.7)	25 (13.9)	9 (5.0)	2.30	1.21	11.50	7
9.	Refraction through lenses	71 (39.4)	23 (12.8)	36 (20.0)	41 (22.8)	9 (5.0)	2.41	1.34	12.06	4
10.	Application of light waves	68 (37.8)	26 (14.4)	26 (14.4)	27 (15.0)	33 (18.3)	2.62	1.55	13.08	1

N = 180

The Relative Strength Index (RSI) was calculated to provide a standardized measure of perceived difficulty across the listed physics topics. This allowed for the topics to be ranked based on their RSI values, with the highest RSI ranked first and the lowest ranked last. This comparative analysis enabled the determination of the topics that students perceived as most or least difficult. Application of light waves was ranked first, dispersion of white light was ranked second, The third ranked item was vibration in string, The fourth ranked item was refraction through lenses, The fifth ranked item was mathematical representation of wave, the sixth ranked item was sources of sound and transmission of sound wave, the seventh ranked item was electromagnetic wave, the eighth ranked item was types of musical instrument, The ninth ranked item was classification of wave and wave motion was ranked item tenth.

Research Question Two: What are the abstract concepts in waves in the curriculum of Physics in secondary schools from students' perception?

Table 2: Descriptive Statistics on Abstract Concepts in Waves in Secondary school physics from students' perception

S/n	Concepts	Level of abstractness					$\bar{X}$	St. D	RSI	Rank
		NA	LA	MA	HA	EA				
1.	Trough and Crest	86 (47.8)	33 (18.3)	34 (18.9)	19 (10.6)	8 (4.4)	2.06	1.22	10.28	10
2.	Resonance	53 (29.4)	52 (28.9)	49 (27.2)	20 (11.1)	6 (3.3)	2.30	1.10	11.50	6
3.	Wave Frequency	64 (36.0)	49 (27.5)	38 (21.3)	24 (13.5)	3 (1.7)	2.17	1.11	10.87	9
4.	Wavelength	52 (28.9)	58 (32.2)	40 (22.2)	21 (11.7)	9 (5.0)	2.32	1.15	11.58	5
5.	Amplitude	61 (34.3)	41 (23.0)	39 (21.9)	26 (14.6)	11 (6.2)	2.35	1.25	11.77	4
6.	Wave Speed	65 (36.1)	42 (23.3)	43 (23.9)	20 (11.1)	10 (5.6)	2.27	1.21	11.33	7
7.	Period	73 (40.6)	38 (21.1)	36 (20.0)	25 (13.9)	8 (4.4)	2.21	1.23	11.03	8
8.	Superposition	56 (31.1)	44 (24.4)	32 (17.8)	32 (17.8)	16 (8.9)	2.49	1.33	12.44	3
9.	Interference	51 (28.3)	42 (23.3	33 (18.3)	34 (18.9)	20 (11.1)	2.61	1.36	13.06	2
10.	Polarization	43 (23.9)	39 (21.7)	25 (13.9)	41 (22.8)	32 (17.8)	2.89	1.45	14.44	1

N = 180

Table 2 presents the descriptive statistics of abstracts concepts in wave motions in Senior Secondary School Physics from students' perception.

The Relative Strength Index (RSI) was used to rank the 10-items concept in ascending from the highest abstract to the lowest according to students' perceptions.

Polarization was ranked first, interference was ranked second, superposition was ranked third, the fourth ranked item was amplitude, the fifth ranked item was wavelength, the sixth ranked item was resonance, the seventh ranked item was wave speed, the eighth ranked item was period, the ninth ranked item was wave frequency and crest was ranked item tenth.

Research Question Three: What are the likely reasons for difficulty in wave's concept in senior secondary Physics from students' perception?

Table 3: Descriptive Statistics on Likely Reasons for Abstract Concepts Difficulty in Waves-motion in senior secondary Physics from students' perception

S/N	Statements	SD (%)	D (%)	U (%)	A (%)	SA (%)	$\bar{X}$	St. D	RSI	Rank
1.	The concepts in waves are too many in formulas and laws to memorize.	43 (23.9)	25 (13.9)	29 (16.1)	65 (36.1)	18 (10.0)	2.94	1.365	14.72	2
2.	The concepts in waves do not relate to my day-to-day activities.	27 (15.0)	57 (31.7)	31 (17.2)	49 (27.2)	16 (8.9)	2.83	1.235	14.17	4
3.	There is little or no practical class for the concepts of wave.	20 (11.1)	54 (30.0)	45 (25.0)	42 (23.3)	19 (10.6)	2.92	1.184	14.61	3
4.	The concepts of waves are mathematically complex.	30 (16.7)	32 (17.8)	23 (12.8)	71 (39.4)	24 (13.3)	3.15	1.326	15.75	1
5.	The concepts of waves are not well-explained by the teacher.	49 (27.2)	33 (18.3)	32 (17.8)	36 (20.0)	30 (16.7)	2.81	1.454	14.03	5

N = 180

Table 3 presents likely reasons for abstract concepts difficulty in wave's concepts in senior secondary Physics from students' perception**.** The highest ranked reason was that the concepts of waves are mathematically complex. The second ranked reason was that the concepts in waves are having too many in formulas and law, the third ranked reason was that there was little or no practical class for the concepts of wave, The concepts in waves do not relate to my day-to-day activities was ranked fourth. The concepts of waves are not well-explained by the teacher is ranked fifth.

Research Question Four: What are the likely reasons for abstract concepts difficulty in wave's concept in senior secondary Physics from teachers' perception?

Table 4: Descriptive Statistics on Likely Reasons for Abstract Concepts Difficulty in Waves Concept in senior secondary Physics from teachers' perception

S/N	Statements	$\bar{X}$	St. D
1.	The concepts in waves are too many in formulas and laws to memorize.	2.94	1.365
2.	The concepts in waves do not relate to my day-to-day activities.	2.83	1.235
3.	There is little to no practical class for the concepts of waves.	2.92	1.184
4.	The concepts of waves are mathematically complex.	3.15	1.326
5.	The concepts of waves are not well-explained by the teacher.	2.81	1.454

N = 6

Table 4 presents likely reasons for abstract concepts difficulty in wave's motion at senior secondary Physics from teachers' perception. The highest ranked reason was that the concepts of waves are mathematically complex. The second ranked reason was that the concepts in waves are having too many in formulas and law. The third ranked item reason was that there is little or no practical class for the concepts of wave, The concepts in waves do not relate to my day-to-day activities was ranked fourth and the concepts of waves are not well-explained by the teacher is ranked fifth.

Research Hypothesis: There is no significant difference between teachers' and students' perception on likely reasons

for abstract concepts difficulty in waves at senior secondary Physics

Table 5: Independent Sample t-test on Students' and Teachers' perceptions on likely reasons for abstract concepts difficulty in wave's motion at senior secondary Physics

Variables	N	df	x	t	Sig	Remark
Abstract Concepts	Students 180	182	23.64	0.137	0.891	N.S
	Teachers 6		23.16			

Table 5 shows that the mean score of the students is 23.64 and that of the teachers are 23.16. The difference is not significant, that is, df=178, 0.473. (0.137, p>0.05). This indicates that teachers and students do not differ significantly in their perception on likely reasons for abstract concepts difficulty in waves at senior secondary Physics. Therefore the null hypothesis which states that there is no significant difference between teachers' and students' perception on likely reasons for abstract concepts difficulty in waves at senior secondary Physics is not rejected.

Discussion of Results

The findings of this research study showed that application was ranked as most difficult among the listed wave motion topics due to its abstract nature and the challenge of connecting theory to real-world applications. This is in support of Bouchee *et al* 2022 [6] that many students considered physics colloquial due to the fact it does not connect to ordinary real life experiences. Dispersion of white light was ranked second which was likely due to the need for visual demonstrations and the complexity of light behavior. The third ranked topic was vibration in string indicating that students consider this topic difficult, possibly due to the mathematical modeling and experimental setup lacking. This is in support of research conducted by Damcho, Dumcho, Sonam, & Jampel, (2023) [7] that students find Physics topic difficult because of lack Mathematical skills. The importance of Mathematics was emphasized in making the learning of Physics easier for students, Adebisi (2024) [22] reported that Mathematics is considered to be a sine qua non to Physics and this could be traceable to the nature and laid down activities of the subject in the curriculum itself. A factor often disregarded by students (Williams, Stanisstreet, Spall, & Boyes, 2003) [14].The fifth ranked item was Mathematical representation of wave. This is in line with earlier research that found that students have a hard time with physics ideas that are very mathematical inclined. The findings have shown that reason for difficulty in concept as noted by Physics teachers is mathematics complexity and lack of practical activities. This in support of WAEC Chief Examiners Reports, CER, (2020 [12]- 2024), that a display of poor understanding and difficulty in practical physics concepts are required in the senior school certificate examinations. According to Ekpo, Utibe, and Udofia, (2024) [8], any study of Physics done outside the laboratory incapacitates the Physics students from learning concepts. The results of the findings showed that teachers also towed along the students' perceptions. Vlachos, Stylos, & Kotsis, (2024) [22] supported this that experimental teaching in physics is an integral component that provides a starting point for constructing and understanding knowledge. They further emphasized that experiments in physics teaching are used to attract students' interest, provide them with clear examples of complex concepts from outside world, help them understand the operation of technical devices, and verify various predictions.

Conclusion

The study concluded that both teachers and students confirmed that wave's motion with application and Mathematical involvement are difficult to understand. Besides, the teachers and the students agreed that mathematical complexity, excessive formulas, poor contextualization, and limited practical demonstrations are the main reasons for experiencing difficulty in wave's motion. The implication is that improving teaching strategies to bring real world and extent the concepts of Physics to day to day activities will make learning less difficult for the students, Also, integrating more practical and relatable approaches are essential to teaching of Physics will make the concepts of waves motion less difficult.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Physics students should be encouraged and motivated to improve their Mathematics prowess by making Further Mathematics compulsory for them
2. Outcome of research like this should be made available to stakeholders like the Ministry of Education, parents and Non-government agency who can provide modern laboratory equipment to teach Physics practical
3. Workshop for teachers to train them should be organized to improve their skills in using practical tools to teach relatable to day –to day activities.

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