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An Investigation of Difficult Topics Encountered by Students in Interaction of Matter, Space and Time in Senior Secondary School Physics Curriculum

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Abstract
Despite the description of curriculum on what, why and how well students should learn in a systematic way. Physics curriculum has not been said to have actualize such description when compared with students' performance in physics. The performance of students in physics has been on the decline over the years. Decline in Physics students' performance as highlighted by the chief WAEC examiners report should not be a thing of neglect by both teacher and researchers in science education. Thus, this paper investigated difficult topics encountered by students in interaction of matter, space and time in senior secondary school Physics. Two research questions and two null hypotheses guided the study. Descriptive survey research design was employed for the study. 21,974 senior secondary school one to three (SSS1-3) physics students in 292 senior secondary schools in Anambra state made up the population of the study. The sample size of the study comprised of 393 drawn from the population (that is; 290- urban and 103- rural; 238- male and 155- female). The sample size was drawn using Yaro Yamane formular. Multi stage sampling procedure were used to compose the sample size. Researchers developed instrument titled, 'Interaction of Matter, Space and Time Difficulty Identification Questionnaire (IMSTDIQ)' was used for data collection. The instrument was subjected to face validity by experts from research measurement and evaluation unit, physics education unit, physics and astronomy unit. Cronbach Alpha formula (α) was used to obtain reliability index for IMSTDIQ at 0.79. The reliability index obtained indicated that the instrument is reliable. Research questions 1 & 2 were answered using mean and standard deviation. Independent sampled t-test was used to test hypotheses 1 & 2. All the hypotheses were tested at 0.05 level of significance. Findings revealed that speed and velocity, rectilinear acceleration, equation of uniformly accelerated motion, and simple harmonic motion are the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum based on gender and school location.
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Introduction

Every segment of educational institution operates on a written statutory document called curriculum. Thus, the importance of curriculum in educational system cannot be overemphasised. Curriculum is a deliberate and systematic plan of activities of the school that is usually passed on to the learners in the classroom by the teacher who is implementer of the curriculum content (Nduji, 2019). This implies that the teacher is an important part of the curriculum, because a good teacher can modify both the curriculum and methods to suit his\ her students. In the same vein, good curriculum and methods cannot modify a teacher who is not efficient. Curriculum could be regarded as the heart of institution that serves as a guide for the teachers and also sets the expectations of student. *Curriculum* as an *important* and integral part of education helps to plan, organize, execute and attain results in a systematic approach by strict adherence to its objectives (Glenn, 2022).

It is of no doubt that curriculum objectives are made to *cuts across most subject areas in senior secondary schools. In the aspect of physics curriculum, the general objectives of physics are as follows;* to give fundamental literacy in physics for efficient living in the general public, acquire basic concepts and principles of physics as a preparation for further studies, obtain essential scientific skills and attitude as a preparation for technology application of physics, and to stimulate and enhance creativity (Federal Republic of Nigeria [FRN], 2013, p. ii). Physics curriculum is structured on (14) themes with (56) topics for senior secondary school students one to three (SSS1-3). This implies that in SS1 (4) themes with (15) topics are expected of students to grasp and conceptualize all while that of SS2 and SS3 are (5) themes, with (18) topics, and (5) themes with (23) topics respectively. However, it is important to note that some of the themes in physics curriculum are found in another class level. Though the topics may vary but the themes are the same. For instance, interaction of matter, space and time, conservation principles, energy quantization and duality of matter are all themes that are inclusive in both SS1 and SS2 physics curriculum. Similar thing follows for some other themes in both SS2 and SS3.

Despite the well-structured themes with their topics to aid actualize the stated objectives of physics curriculum, there is still decline in physics students' performance. This could be due to difficulties encountered by students in some of these themes with their respective topics as highlighted by the chief WAEC examiners report specifically from 2015-2020. The report revealed a decline on candidates' performance towards speed and velocity questions. Also, the report showed that majority of the candidates avoided question on equation of uniformly accelerated motion; the few candidates that attempted the questions on equilibrium of forces and motion performed on average; some candidates however, failed to give correct interpretation to the question and so gave wrong answers and many more. Thus, the need to investigate on difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum.

Space and time are universal forms of the existence of matter, the coordination of objects. Matter is an inert material that takes up physical space. Physicists have long believed that a fundamental, encompassing theory of matter, space, and time must be attainable (National Academic Press, 2022). Therefore, the interaction of matter, space and time as a theme in physics curriculum is very paramount. This theme seeks to give insight on how matter, space and time are unified or related. In physics curriculum, the theme interaction of matter, space and time has its topics as follow; fundamental and derived quantities and units, position, distance and displacement, time, motion, speed and velocity, rectilinear acceleration, scalars and vectors. To ensure students mastery of these topics, the physics curriculum has provision for content, teacher and students' activities, evaluation guide, teaching and learning materials. It is therefore expected that when learners are exposed to these topics in the curriculum, and they master and use it, then the objectives of the planned curriculum are achieved. However, physics curriculum takes no cognizance of the way difficulties are encountered by learners in some of these topics.

Difficulties encountered by learners or students in a traditional classroom learning context is called learning difficulties. Learning difficulties are disorder in which a person's capacity to learn properly requires a great deal of effort, and is caused by an unknown reason or variables that limit the brain's ability to accept and process information. Learning difficulties are sometimes referred to as *learning disabilities.* You may also encounter the terms *learning differences* or *specific learning differences or* specific learning difficulties. According to World Health Organization (WHO, 2010), specific learning difficulties consist of basic reading, spelling and arithmetic problems (F81, that is Specific developmental disorders of scholastic skills). A child or adult with specific learning difficulty may require additional time to complete assignments at school and can often benefit from strategy instruction and classroom accommodations. In classroom setting, a students' learning difficulty may vary based on how the student sees himself or herself. Learning difficulties are of different types which are; dyslexia, attention *difficulties,* dysgraphia, dyscalculia and dyspraxia (Meredith, 2022). Dyslexia is not associated with language difficulties which could cause children to believe they are less intelligent than their peers and result in low-confidence and a poor self-image. Attention *difficulties deals with students' possession of* poor impulse control, fidgety, and messy written work. Dysgraphia means struggling hard with handwriting. Thus, typing on the computer is often a recommended by this group at school. Dyscalculia deals with the problem of performing simple arithmetic while dyspraxia is a motor skills difficulty that can also impact on academic success (Meredith, 2022). This implies that a student with learning difficulties may have problems with reading, writing, paying attention in class (verbal) or mathematics (non-verbal). They may also be disengaged or show signs of poor social-emotional health. This indicates that the challenge of students having learning difficulties specifically in physics should be a thing of concern for researchers, thus the need for the study.

However, factors that contributes to students' learning difficulties could be attributed to genetic influences, brain progress, environmental effects (**Grodzinsky, 2018**), school location and gender (Saleh, 2022) among others. School location refers to the community in which the *school* is situated, such as a village, hamlet, metropolis or cities. According to Nduji (2020), in a physical environment, a school can be positioned either in an urban or rural areas. The concept of school location as one of the factors contributing to students' learning difficulties especially in Nigeria could emanate from disparity observed in the distribution of social amenities like pipe borne water, electricity, healthcare facilities within urban and rural schools. Also, same thing applies to educational facilities. This is in-line with the views of Ntibi and Edoho (2017) that urban schools have more educational opportunities than their counterparts in rural schools have. Thus, the prevailing condition implies that learning opportunities in Nigerian schools differ from school to school which is suspected to affect students' academic achievement. It appears that students in Nigerian urban schools have greater educational chances than their rural counterparts. While some studies have found a favourable impact of school location on students' learning outcomes or accomplishment, others have found a detrimental impact. Some of these studies are (Abamba, 2021; Awodun, & Oyeniyi, 2018; Adesegun, Adekunle & Emmanuel, 2016; Nworgu & Ugwuanyi, 2014) with their reports indicating that school location has significant influence on students' academic achievement in sciences. From the reviewed literature based on this study, the researcher noticed that there is no existing literature on the specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum based on school location. Hence, the inclusion of school location

as a moderating variable in this study.

On the other hand, another factor that could contribute to students' learning difficulties is gender. The term gender is a socially constructed characteristics pertaining to femininity and masculinity. According to Nduji & Madu (2020), gender is the normative way (or standard) people act and feel in the manner the society describes them. This means that throughout life (birth to death) human feelings, thought and actions reflect the social definition that people attach to gender which affect the individual's daily activities positively or negatively. Hence, the effect of gender in the society is admitted by Babajide (2011), who believe that science subjects such as physics, mathematics and chemistry are given masculine outlook by education practitioners and many in the society. This is because of the ill-belief of male supremacy and gender stereotype in the society. In the same light, Amaechi (2013) who inferred that male student are more attracted to critical and quantitative reasoning while females prefer writing and verbal reasoning. The societal stereotype attached to gender could be the reason gender is attributed to as one of the factors that contributes to students' learning difficulties.

However, research from reviewed literature based on this study have shown that; gender is not a significant factor in determining specific difficulties encountered in map reading and interpretation in geography (Saleh, 2022), there is no significant difference on the specific difficulties encountered in computer studies in secondary schools based on gender (Anierobi, 2019; Adigun, Onihunwa, Irunokhai, Sada & Adesin, 2015). This indicates that there is an existing gap in the body of knowledge on if gender has a moderating influence on the cause of difficulties encountered by students in physics especially on the topics, interaction of matter, space and time. This triggered the researcher's interest towards investigating on the specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum.

Research Questions

The following questions were posed to guide the study:

1. What are the specific difficult topics encountered by male and female students in interaction of matter, space and time in senior secondary school physics curriculum?
2. What are the specific difficult topics encountered by urban and rural students in interaction of matter, space and time in senior secondary school physics curriculum?

Hypotheses

The following null hypotheses guided the study.

1. The specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum do not depend significantly on gender ($p< 0.05$).
2. The specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum do not depend significantly on location ($p< 0.05$).

Methods

The researchers employed descriptive survey research design. The population of the study comprised of 21,974 senior secondary school one to three (SSS1-3) physics students in 292 senior secondary schools in Anambra state. The sample size of the study comprised of 393 senior secondary school physics students that is; 290- urban and 103- rural; 238- male and 155- female. The sample size was drawn from the population using Yaro Yamane formular. Multi stage sampling procedure were used to compose the sample size. Researchers developed instrument titled, 'Interaction of Matter, Space and Time Difficulty Identification Questionnaire (IMSTDIQ)' was used for data collection. IMSTDIQ was constructed from the new senior secondary school physics curriculum. IMSTDIQ has two sections: A, and B. Section A has bio-data information on students' gender and school location; section B consists of 11 item questions which tries to extract information on difficult topics on interaction of matter, space and time difficulty identification in Physics. IMSTDIQ is structured in four Likert scales of Very Difficulty (VD), Difficult (D), Easy (E), and Very Easy. The instrument was subjected to face validity by experts from research measurement and evaluation unit, physics education unit and physics and astronomy unit. Cronbach Alpha formula (α) was used to obtain reliability index for IMSTDIQ at 0.79. The reliability index obtained indicated that the instrument is reliable. The instrument for data collection was administered with the help of research assistants in each of the sampled school. On the spot administration and collection of data was used during field work. This ensured high percentage of the instrument returned. Research questions 1 & 2 were answered using mean and standard deviation. The benchmark for mean ratings is 2.50. This means that any item with mean ratings of 2.50 and above is accept while any item with mean ratings below 2.50 is reject. Independent sampled t-test was used to test hypotheses 1 & 2. All the hypotheses were tested at 0.05 level of significance. The decision rule for accepting null hypotheses was based on p-value. Any null hypothesis that its p-value is greater than 0.05 level of significance were accepted while any null hypothesis that its p-value is less than 0.05 level of significance were rejected.

Result

Research Question One: What are the specific difficult topics encountered by male and female students in interaction of matter, space and time in senior secondary school physics curriculum?

Table 1: Mean and standard deviation of the ratings of male and female students on their specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum

		Male=238	**Female= 155**		
S/N	Item statement	Gender	Mean	S. D	Dec
	I encounter difficulties in:				
1	Fundamental and derived quantities and units	Male	2.40	.618	Disagree
		Female	3.53	.776	Agree
2	Position, distance and displacement	Male	2.34	.857	Disagree
		Female	3.21	.811	Agree
3	Time	Male	2.48	.754	Disagree
		Female	3.31	.818	Agree
4	Motion	Male	2.39	.781	Disagree
		Female	3.27	.800	Agree
5	Speed and velocity	Male	3.20	.821	Agree
		Female	3.06	.944	Agree
6	Rectilinear acceleration	Male	3.32	.679	Agree
		Female	3.17	.851	Agree
7	Scalars and vectors	Male	2.39	.735	Disagree
		Female	3.32	.764	Agree
8	Equation of uniformly accelerated motion	Male	3.17	.788	Agree
		Female	3.16	.734	Agree
9	Equilibrium of forces	Male	2.07	.891	Disagree
		Female	2.47	.868	Disagree
10	Projectiles	Male	2.49	.905	Disagree
		Female	3.04	.896	Agree
11	Simple harmonic motion	Male	3.03	.759	Agree
		Female	3.30	.801	Agree

NB: S. D= Standard deviation; Dec.= Decision

Table 1 shows the mean ratings of male and female students on their specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum. It shows that the mean ratings of male students on items 1, 2, 3, 4, 7 & 10 are less than the 2.50 criterion mean meaning that male students disagree on having specific difficult topics encountered with regards to the item statements. However, female students who responded to items 1, 2, 3, 4, 7 & 10 shows mean ratings of above 2.50 which indicates that female students agree on having specific difficult topics encountered with regards to the item statements. Also, the result shows that the mean ratings of male and female students on items 5, 6, 8 & 11 are greater than the 2.50 criterion mean, meaning that both male and female students agree on having specific difficult topics with regards to the item statements. Besides, item 9 with the mean rating of below 2.50 shows that both male and female students disagree with the item statement as a difficult topic. Therefore, table1 reveals that speed and velocity, rectilinear acceleration, equation of uniformly accelerated motion, and simple harmonic motion are the specific difficult topics encountered by male and female students in interaction of matter, space and time in senior secondary school physics curriculum.

Hypothesis One: The specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum do not depend significantly on gender

Table 2: t-test analysis of the difference in the mean ratings of male and female students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum

Gender	**N**	**Mean**	**SD**	**df**	**t-**	**Sig.**
Male	238	2.66	.780	391	3.038	0.003
Female	155	3.16	.823			

NB: n = number of male and female respondents; SD = standard deviation; df = degree of freedom; t- = t-test value; Sig. = probability value.

Analysis in Table 2 shows that the probability associated with the calculated t (3.038) for the difference in the mean ratings of male and female students on their specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum is 0.003. Since the probability value of 0.003 is less than 0.05 level of significance, the null hypothesis was rejected. This implies that there is a significant difference in the mean ratings of male and female students on the specific difficult topics encountered

in interaction of matter, space and time in senior secondary school physics curriculum.

Research Question Two: What are the specific difficult topics encountered by urban and rural students in interaction of matter, space and time in senior secondary school physics curriculum?

Table 3: Mean and standard deviation of the ratings of urban and rural students on their specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum

Urban = 290 Rural= 103

S/N	Item Statement	Location	Mean	S. D	Dec.
	I encounter difficulties in:				
1	Fundamental and derived quantities and units	Urban	2.46	.692	Disagree
		rural	3.56	.813	Agree
2	Position, distance and displacement	urban	2.30	.792	Disagree
		rural	3.25	.860	Agree
3	Time	urban	2.46	.721	Disagree
		rural	2.38	.709	Disagree
4	Motion	urban	2.39	.703	Disagree
		rural	3.21	.882	Agree
5	Speed and velocity	urban	2.78	.892	Agree
		rural	3.05	.954	Agree
6	Rectilinear acceleration	urban	2.28	.795	Disagree
		rural	3.20	.833	Agree
7	Scalars and vectors	urban	2.68	.796	Agree
		rural	3.32	.770	Agree
8	Equation of uniformly accelerated motion	urban	2.51	.796	Agree
		rural	3.04	.862	Agree
9	Equilibrium of forces	urban	2.08	.924	Disagree
		rural	2.88	.900	Agree
10	Projectiles	urban	3.14	.941	Agree
		rural	3.11	.862	Agree
11	Simple harmonic motion	urban	2.48	.886	Disagree
		rural	3.40	.784	Agree
	Grand Mean	**urban**	**2.43**	**.810**	**Disagree**
		rural	**3.12**	**.839**	**Agree**

NB: S. D= Standard deviation; Dec.= Decision

Table 3 shows the mean ratings of urban and rural students on their specific difficulties encountered in interaction of matter, space and time in senior secondary school physics. It shows that the mean ratings for urban male students on items 1, 2, 4, 6, 9 & 10 are less than the 2.50 criterion mean meaning that urban students disagree on having specific difficulties encountered with regards to the item statements. However, rural students who responded to same items shows mean ratings of above 2.50 which indicates that rural students agree on having specific difficulties with regards to the item statements. Also, the result shows that the mean ratings of urban and rural students on items 5, 7, 8 & 11 are greater than the 2.50 criterion mean, meaning that both urban and rural students agree on having specific difficulties with regards to the item statements. Besides, item 3 with the mean rating below 2.50 shows that both urban and rural students disagree with the item statement. Therefore, **table 3** reveals that speed and velocity, equation of uniformly accelerated motion, scalars and vectors, and projectiles are the specific difficult topics encountered by urban and rural students in interaction of matter, space and time in senior secondary school physics curriculum.

Hypothesis Two: The specific difficult topics encountered by students in interaction of matter, space and time in senior secondary school physics curriculum do not depend significantly on location

Table 4: t-test analysis of the difference in the mean ratings of urban and rural students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum

Gender	N	Mean	SD	df	t-	Sig.
Urban	290	2.43	.810	391	2.319	0.021
Rural	103	3.12	.839			

NB: n = number of male and female respondents; SD = standard deviation; df = degree of freedom; t- = t-test value; Sig. = probability value.

Analysis in Table 4 shows that the probability associated with the calculated t (2.319) for the difference in the mean ratings of urban and rural students on their specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum is 0.021. Since the probability value of 0.021 is less than 0.05 level of significance, the null hypothesis was rejected. This implies that there is a significant

difference in the mean ratings of urban and rural students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum.

Discussions

The finding of the study revealed that in senior secondary school physics curriculum, speed and velocity, rectilinear acceleration, equation of uniformly accelerated motion, and simple harmonic motion are the specific difficult topics encountered by male and female students in interaction of matter, space and time. These four physics topics out of eleven topics has been identified by male and female students as specific difficult topics in interaction of matter, space and time. This could be as a result of challenges of access or lack of resources for teaching and the absence of test items of the theme during national and local assessment (Bada & Loyiso, 2020). Further analysis revealed that the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum is not statistically significant based on gender. The finding is in agreement with that of Bichi, Ibrahim and Ibrahim (2012) whose study unveiled that students' gender had a significant influence on their perception of difficult topics in mathematics. On the other hand, the finding is not in agreement with that of Alghail and Mahfoodh (2016) who showed that most of the academic reading difficulties faced by international graduate students are as follows; taking brief and relevant notes, using their own words in note taking, working out meaning of difficult words, identifying supporting ideas/examples, and managing their time for completion of reading academic materials. Assaf (2015) reported that lacking background information about the topic, noises around and poor-quality listening equipment are the difficulties encountered by EFL learners.

The research finding discovered that speed and velocity, equation of uniformly accelerated motion, scalars and vectors, and projectiles are the specific difficult topics encountered by urban and rural students in interaction of matter, space and time in senior secondary school physics curriculum. This means that out of eleven topics in the item statements, urban and rural students encountered specific difficulties in four topics. It could be due to some underlying factors like; too many calculations, teacher not helpful, problems not easy to solve, it is more of theories and too many formulae to memorize (Nduji, Onuya, Okeke & Nweke, 2022). Also, based on the finding there is a significant difference in the mean ratings of urban and rural students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum. This is an indication that specific difficult topics encountered by students in interaction of matter, space and time is a perception of their school location. The finding is not in agreement with the findings of Saleh (2022) whose study showed that school location is not a significant factor in determining specific difficulties encountered in map reading and interpretation in geography, location of places on maps, mathematical calculations in geography, drawing of diagrams of physical features, in differentiating climatic types. The result of this study therefore contrasts with that of Ugwuanyi, Nduji, Elejere and Omeke (2020); Nduji and Kemsi (2019) who revealed that there exist gender differences in science achievement in the schools.

Conclusion

Based on the discussion of the findings, the following conclusions were made, thus; the specific difficult topics encountered by male and female students in interaction of matter, space and time in senior secondary school physics curriculum are speed and velocity, rectilinear acceleration, equation of uniformly accelerated motion, and simple harmonic motion. Besides, there is a significant difference in the mean ratings of male and female students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum. Also, speed and velocity, equation of uniformly accelerated motion, scalars and vectors, and projectiles are the specific difficult topics encountered by urban and rural students in interaction of matter, space and time in senior secondary school physics curriculum. There is a significant difference in the mean ratings of urban and rural students on the specific difficult topics encountered in interaction of matter, space and time in senior secondary school physics curriculum.

Recommendations

Based on the conclusion of the findings, the researcher made the following recommendations:

1. Curriculum developers should ensure the infusion of a comprehensive instructional activities and time allocated for these identified difficult concepts.
2. Physics teachers should endeavor to possess the required competences or knowledge on identified difficulties encountered by students. This will help bring students to better perception of these concepts.
3. Authors of physics textbooks, practical books and workbooks should take cognizance of the identified difficulties encountered by students while writing. This will help improve students understanding and achievement in physics.

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