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Students' Conceptions in Conservation of Energy and Momentum: The Moderating Influence of Gender and Location

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Abstract

The purpose of the study was to ascertain students' conceptions in conservation of energy and momentum: the moderating influence of gender and location. Descriptive survey design was employed for the study. The population of the study was 11,784 senior secondary school two (SSS2) physics students in Enugu state. A sample size of 361 senior secondary school two (SSS2) physics students was drawn from the population using multistage sampling procedure. The instrument for the study, Conception Test on Laws of Conservation of Energy and Momentum (CTLCEM) was developed by the researchers and subjected to face and content validity. The reliability coefficient of 0.71 was obtained for CTLCEM using Cronbach alpha formula. Frequency and percentage were used to answer the research questions while all the null hypotheses were tested using Chi-square at 0.05 level of significance. Findings: gender and school location have no significant influence on student's conception of laws of energy and momentum in physics. The need for physics teachers to resolve the preconceived notion of students in the course of teaching was recommended.

Keywords: Students' conception, energy and momentum, physics

Introduction

The inability of most students having the right conception of concepts taught in the classroom have been a concern in recent time. This is because most students have different views about various concepts being taught in class. Students also have difficulty in relating a concept to the real-life situations, thus, they often see physics as an abstract subject. This could be attributed to the fact that some students conceive concepts based on how their environment relates it to them. It has also been revealed by previous studies that gender could play a role in influencing the way students conceive concepts especially in physics. Additionally, previous researchers have made various efforts addressing the issue of poor students' conception of concepts in physics, but despite this, the problem still persist (Nduji, Onuyah, Madu, & Okeke, 2022). Based on this, the need to investigate on "the influence of gender and school location on students' conceptions in conservation of energy and momentum in physics" becomes paramount.

Physics is an aspect of physical sciences that deals with the study of matter, energy and how they relate to one another. According to Halliday, Walker and Resnick (2023), the understanding of physics lies on one's ability to grasp the underlying principles in physics. Some of the principles in physics include mass, force, Newtons laws of motion, momentum, conservation of energy among others (Mengs, 2023). Based on the purpose of the study, the researchers' interest in the principle of laws of conservation of energy and momentum. Conservation laws are fundamental to the understanding of the physical world, because they describe which processes can or cannot occur in nature. In this study, conservation of energy and momentum is defined as the total energy or momentum of an isolated system remains constant.

Conservation law in physics is based on Newton's laws of motion and it states that certain physical properties (i.e. measurable quantities) do not change in the course of time within an isolated physical system (Maudlin, Okon & Sudarsky, 2020). For example, the law of conservation of energy states that energy can neither be created nor destroyed but can be changed from one form to another. This means that

when a swinging pendulum is upward, kinetic energy is converted to potential energy as when the pendulum stops the kinetic energy is zero, and all the energy in the system is in potential energy. However, when the pendulum swings back, the potential energy is converted back into kinetic energy. Therefore, at all times the sum of potential and kinetic energy is constant. The knowledge of conservation of energy and momentum is very crucial because it helps students understand how the natural world works (Brundage, Maries & Singh, 2023). This is due to the fact that conservation of energy and momentum are the universal principles that govern all physical processes from everyday collisions to planetary motion and modern technology. Despite the importance of conservation of energy and momentum, students have consistently shown poor conception of this concept over the years (Reddy & Panacharoensawad, 2017). This is also in line with the report by Chief examiner, West African Examination Council ([WAEC], 2021-2023) that most students lack of knowledge of applying physics principles and concepts to real life situations, poor mathematical skill in solving momentum problems, lack of basic knowledge of the principle of conservation of energy and momentum, inability to correctly state the principle of conservation of linear momentum as well as give relevant examples.

The outlined weaknesses experienced by students in physics could be linked with the process leading to their knowledge construction. This process leading to knowledge construction is termed conceptual change. This means that, for a student to construct their knowledge, there must be a shift in cognitive structures and frameworks as that student encounter new information, experiences, or explanations that challenge their preconceived notions (Navaneedhan, 2017). Before such shift in cognitive structure, the student may have been having incomplete understandings of such concept, despite contrary evidence or explanations (Hidayat, Agus, Yolviansyah, Octavia & Iqbal, 2022). This incomplete understanding of a concept is termed misconception. According to Omilani and Anifowose (2022), a student who has misconception about a concept can have a shift towards the right conception, once that student possesses the following; relevant prior knowledge, engage in accurate learning experience, actively process information, receive feedback and clarification. Nevertheless, students possess many false ideas that are contrary to correct scientific conceptions of some concepts.

Students' conception is an understanding of idea(s) about a concept and can be experienced in any field or discipline. Studies have shown that students can exist at different categories or levels of conception such as scientific conception, partial understanding, alternative conception and naive conception (Nduji & Madu, 2020); sound understanding, partial understanding with specific alternative conception, specific alternative conception, and no understanding (Wangdi, Kanthang & Precharattana, 2017). To this end, the researchers in the present study categorized students' conceptions as scientific conception (SC), partial conception (PC), alternative conception and no conception (NC). Scientific conception (SC) means the right or correct understanding of a concept. This type of understanding is required of students to possess and showcase once question(s) is posed to them. At this level, the learner constructs knowledge by making connections with previous experiences which shows confidence in knowledge (Nduji, Onuyah, Madu & Okeke, 2022). Partial understanding is part or incomplete idea about a topic (Okeke, 2024). This implies that a student with partial conception may be biased in choice of answer since the student has incomplete information about such topic. Alternative conception (AC) is seen as the students' notion which is not steady with scientific conception (Mchunu & Imenda, 2018). This implies that students' predictions are made with no confidence about a concept. No conception (NC) is the limited or inappropriate information about a concept. Students that occupy this level are believed to have been taught the concept but fail to give complete answer to question being posed to them (Wanning, 2018). To this end, Pika (2017) stated that the level of conception a student has about a concept could be attributed to their experiences or prior conception. The prior conception of a student about a concept differs by gender (Erdal & Münir 2017). This implies that male and female students often have different initial understandings, beliefs, or perceptions about a particular concept before they receive formal instruction on it. To this end the researcher deemed it fit to ascertain if gender has influence on students' conception of laws of conservation of both energy and momentum.

Gender is a social-construct attributed to both male and female. Gender encompasses a wide range of characteristics which includes gender expression, and gender roles (Okeke, 2022). Despite recent advancement in science, research shows that physics has one of the largest gender gaps in science (Holman,

Stuart-fox, & Hauser, 2018). Nduji (2019) observed that there is very poor female enrolment in the field of physics, hence, leading to physics being regarded as a male dominated field of study. Also, previous studies have not been consistent on whether gender has influence on students' conceptions in physics (Atsuwe & Mtoh, 2019; Osadebe & Oghomena, 2018). It is therefore crucial to ascertain the influence of gender on student's levels of conceptions of the laws of conservation of energy and momentum. This necessitated the need for the present study. Though, conception of male and female students in different school location may vary (Okeke, 2024). This means that the place where a school is cited could determine the conceptual level a student may possess in physics. Thus, location could shape the preconception of a student about a concept due to differences in cultural background, community values across locations.

School location refers to the community in which the school is located, such as a rural area also referred to as village and urban area which is regarded as a town or city. It has been revealed that poor conceptions physics concepts among secondary school students in rural areas are six times more than that of students in the urban area (Ahiakwo & Isiguzo, 2015). Additionally, previous research studies revealed that; school location is not a significant factor in determining students conception of conservation of energy and momentum (Nduji & Madu, 2020); students in urban areas performed better than students in the rural area (Amadi, Nnamani & Ukoha, 2018); there is a significant difference on students conceptions in science based on school location (Ezechi & Adukwu, 2018); students in urban areas had better conception than students in rural areas (Woldeamanuel, Abate & Berhane, 2020). These inconsistent research findings on the influence of school location on student's conception in physics led to the importance of the present study. From the discussion, it is clear that the influence of gender and school location on students' conceptions in physics have not been conclusive. Also, none of the studies used totality of senior secondary schools in Enugu state as the population of respondents in their respective studies. On this note, the present study identified the moderating influence of gender and location on student conceptions of conservation of energy and momentum particularly in Enugu State, Nigeria.

The general purpose of the study was to ascertain the moderating influence of gender and location on students' conceptions in conservation of energy and momentum. Specifically, the study sought to ascertain the;

1. the influence of gender on students' levels of conceptions in conservation of energy and momentum?
2. the influence of school location on students' levels of conceptions in conservation of energy and momentum?

The following research questions and null hypotheses were posed for the study. The null hypotheses were tested at 0.05 level of significance. Thus;

1. What is the influence of gender on students' levels of conceptions in conservation of energy and momentum?
2. What is the influence of school location on students' levels of conceptions in conservation of energy and momentum?

It was hypothesized that;

1. Students' conception of laws of conservation of energy and momentum is not significantly influenced by gender.
2. Students' conception of laws of conservation of energy and momentum is not significantly influenced by school location.

Research Method

The researchers adopted descriptive survey design. The study was carried out in Enugu State, Nigeria. Enugu State has 6 education zones; Agbani, Enugu, Nsukka, Obollo-Afor, Awgu, and Udi with 17 local government areas (LGA). The population of the study was 11,784 senior secondary school two (SSS2) physics students from 293 senior secondary schools in all the government owned senior secondary schools within Enugu state during 2023/2024 academic session. The population distribution of students based on their gender includes; 7,365 male and 4,419 female students. The choice of SSS2 students is because the units used in the study are contained in SS2 scheme of work and also the students might have learnt the fundamentals of laws conservation of energy and momentum in their penultimate year (SS1).

The sample size of the study was 361 senior secondary school two (SSS2) physics students (that is 162 males and 199 females) drawn from the population. 253 SS2 students are from urban (that is 112 males and 141 females) and 108 are from rural schools (that is 50 males and 58 females). Multi-stage sampling procedure was used in composing the sample. Firstly, simple random sampling technique with replacement was used to select two education zones from the six zones in the

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state. At the end, the following education zones emerged namely, Enugu and Udi. Secondly, purposive sampling technique was used to select one LGA each from the two selected education zones. This is because the researchers are interested in the variable of location. At the third stage, purposive sampling technique was used to select five (5) coeducational schools each from the two selected local governments since not all the schools are mixed with both male and female students. This gave a total of 10 schools. Thirdly, proportionate stratified random sample technique was used to draw the number of students to be studied in each school that was sampled from each LGA resulting to the total number of 361 SS2 physics students.

The instrument for the study was a Conception Test on Laws of Conservation of Energy and Momentum (CTLCEM), which was developed by the researchers. The instrument had 18-items essay test with two sections A&B. Section A elicited information on respondents' demographic data while section B was on the conception of the students. At first, the instrument (CTLCEM) was subjected to content validation by preparation of table of specification. The table of specification covers the six (6) cognitive domains based on the modified Bloom's taxonomy of cognitive domain and all the topics on laws of conservation of energy and momentum as enshrined in SSII Physics scheme of work (2nd Term). Subsequently, the instrument was face validated by three specialists; one from physics and astronomy department; two (2) from science education department specifically, one measurement and evaluation and one physics education specialist all from the University of Nigeria Nsukka. Cronbach Alpha formula (α) was used to estimate the internal consistency index of CTLCEM which gave a coefficient of 0.71.

The researchers employed one physics teacher from each of the sampled schools as the research assistants. These physics teachers were intimate on the purpose of the study, how to administer and retrieve the instrument from the respondents. While administering the instrument, the research assistant emphasized that the respondents should read and understand the instructions before responding to the instrument. The administration of the entire instrument was done once, and retrieval of the whole instrument was on the spot. This was done to ensure 100% retrieval of the instrument. Data collected were scored on four-point scale (4-1). Where, students who showed scientific conception were assigned 4. Also, students who show Partial Conception were assigned 3, Alternative Conception were assigned 2 and 1 to No Conception. Frequency and percentage were used to answer the research questions while all the null hypotheses were tested using chi-square at 0.05 level of significance.

Results

The result of this study was presented in this section. The analysis of data for this study with respect to each research question and hypothesis raised were presented using tables and bar chart.

Table1: Frequency, Percentage and Chi-square Analysis of Influence of Gender on Students' Conception of Laws of Conservation of Energy and Momentum

	Male (N = 164)				Female (N =197)							
Item No.	**SC f(%)**	**PU f(%)**	**AC f(%)**	**NC f(%)**	**SC f(%)**	**PU f(%)**	**AC f(%)**	**NC f(%)**	**χ^2**	**df**	**p-value**	**Dec.**
1	6(3.7)	19(11,6)	51(31.1)	88(53.7)	5(3.0)	31(15.7)	60(30.5)	101(51.3)	1.591	3	0.661	NS
2	9(5.5)	14(8.5)	47(28.7)	94(57.3)	4(2.0)	20(10.2)	53(26.9)	120(60.9)	3.514	3	0.319	NS
3	3(1.8)	11(6.7)	32(19.5)	118(72.0)	6(3.0)	14(7.1)	30(15.2)	147(74.6)	1.595	3	0.661	NS
4	3(1.8)	8(4.9)	20(12.2)	133(81.1)	7(3.6)	4(2.0)	19(9.6)	167(84.8)	3.828	3	0.281	NS
5	2(1.2)	10(6.1)	26(15.9)	126(76.8)	4(2.0)	9(4.6)	38(19.3)	146(74.1)	1.435	3	0.697	NS
6	1(0.6)	9(5.5)	30(18.3)	124(75.6)	4(2.0)	12(6.1)	27(13.7)	154(78.2)	2.629	3	0.452	NS
7	0(0.0)	5(3.0)	36(22.0)	123(75.0)	6(3.0)	7(3.6)	52(26.4)	132(67.0)	6.599	3	0.086	NS
8	2(1.2)	10(6.1)	32(19.5)	120(73.2)	2(1.0)	5(2.5)	24(12.2)	166(84.3)	7.252	3	0.044	S
9	6(3.7)	3(1.8)	17(10.4)	138(84.1)	9(4.6)	8(4.1)	9(4.6)	171(86.8)	5.891	3	0.117	NS
10	4(2.4)	14(8.5)	23(14.0)	123(75.0)	9(4.6)	15(7.6)	17(8.6)	156(79.2)	3.776	3	0.287	NS
11	10(6.1)	12(7.3)	31(18.9)	111(67.7)	4(2.0)	20(10.2)	22(11.2)	151(76.6)	9.267	3	0.026	S
12	7(4.3)	12(7.3)	14(8.5)	131(79.9)	4(2.0)	11(5.6)	30(15.2)	152(77.2)	5.266	3	0.153	NS
13	7(4.3)	4(2.4)	8(4.9)	145(88.4)	4(2.0)	5(2.5)	10(5.1)	178(90.4)	1.519	3	0.678	NS

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14	10(6.1)	3(1.8)	11(6.7)	140(85.4)	5(2.5)	4(2.0)	13(6.6)	175(88.8)	2.872	3	0.412	NS
15	7(4.3)	8(4.9)	7(4.3)	142(86.6)	7(3.6)	5(2.5)	9(4.6)	176(89.3)	1.574	3	0.665	NS
16	3(1.8)	8(4.9)	8(4.9)	145(88.4)	9(4.6)	14(7.1)	8(4.1)	166(84.3)	3.063	3	0.382	NS
17	3(1.8)	6(3.7)	36(22.0)	119(72.6)	2(1.0)	10(5.1)	35(17.8)	150(76.1)	1.785	3	0.618	NS
18	2(1.2)	14(8.5)	22(13.4)	126(76.8)	7(3.6)	16(8.1)	28(14.2)	146(74.1)	2.103	3	0.551	NS
Overall No. of Students	**5(2.8)**	**9(5.7)**	**25(15.4)**	**125(76.1)**	**5(2.7)**	**12(7.1)**	**26(13.6)**	**154(76.6)**	**3.642**	**3**	**0.393**	

NB: n= Number of Respondent; NC= No Conception; AC= Alternative Conception; PU= Partial Understanding; SC= Sound/Scientific Conception; f= Frequency; %= Percentage; χ^2= Chi-Square; p-value= Probability value; df= Degree of freedom

Table 1 shows the frequency, percentage and chi-square analysis of influence of gender on students' conception of laws of conservation of energy and momentum in physics. The result reveals that most male and female students exhibit low levels of conceptual understanding of laws of energy and momentum. This was because No Conception (NC) was the most dominant category across all items, ranging from 88% (Item 1) to as high as 145% (Item 13 & 16) for male students, while for female students are 101% (Item 1) to as high as 178% (Item 13). This implies that NC is high for male and female students. Thus, few students have SC of laws of conservation of energy and momentum in senior secondary school physics. The analysis also showcased the overall f(%) of male students that have SC-5(2.8%); PU-9(5.7%); AC-25(15.4%) and NC-125(76.1%). For female students 5(2.7%) have SC; 12(7.1%) have PU; 26(13.6%) have AC and 154(76.6%) have NC. This means that both male and female students have highest frequency on NC which is naive understanding of laws of conservation of energy and momentum concept. NC is followed by AC, and PU which have low frequency. Besides, the lowest frequency is indicated at the SC level. Thus, both male and female students' conception of laws of conservation of energy and momentum is not scientific. However, the chart (figure 1) below revealed distribution of male and female students' conceptions on laws of conservation of energy and momentum.

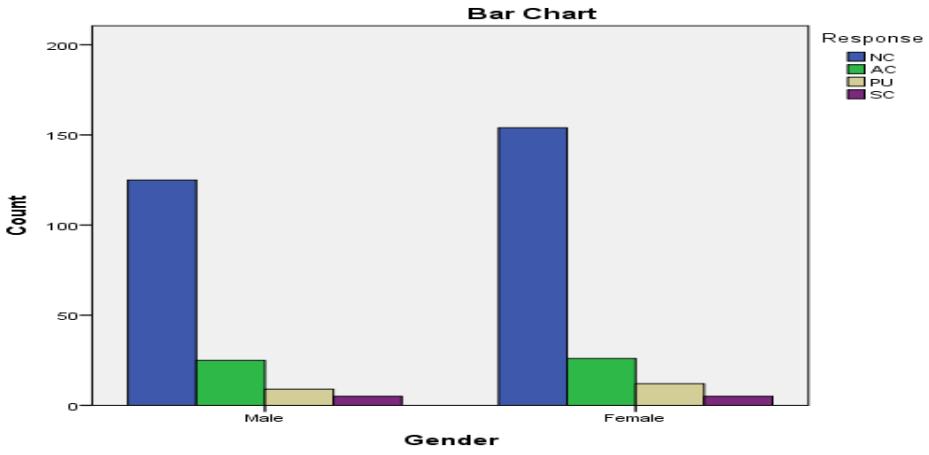

Fig.3: Histogram Showing the Distribution of Male and Female Overall Conception on Conception Test on Laws of Conservation of Energy and Momentum (CTLCEM)

The chart has its tallest and smallest bar in both gender (male and female) which is NC and SC respectively. This shows that male and female students do not have the required conception of laws of conservation of energy and momentum since SC has the smallest bar while NC has the tallest bar. Nevertheless, the influence of gender on students' conception of laws of conservation of energy and momentum was further investigated by testing the hypothesis below.

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Table 2: Overall Trace Analysis of Influence of Gender on Students' Conception of Laws of Conservation of Energy and momentum in Senior Secondary School Physics

		Students' Conceptual Levels				Total	χ^2	Df	p-value	Decision
		SC	PU	AC	NC					
Gender	Male	5	9	25	125	164	0.450	3	0.930	NS
	Female	5	12	26	154	197				
	Total	**10**	**21**	**51**	**279**	**361**				

Note: NC= No Conception; AC= Alternative Conception; PU= Partial Understanding; SC= Sound/Scientific Conception; NS= Not Significant; χ^2= Chi-Square; p-value= Probability value; df= Degree of freedom

The result presented in Table 2, shows the result on influence of gender on students' conception of laws of conservation of energy and momentum. The probability value (0.930) is greater than the level of significance (0.05). This gave the decision that the hypothesis is NS (Not Significant), thus, the null hypothesis was upheld by the researcher. This implies that students' conception of laws of conservation of energy and momentum in senior secondary school physics is not significantly influenced by gender.

Table 3: Frequency, Percentage and Chi-square Analysis of Influence of School Location on Students' Conception of Laws of Conservation of Energy and Momentum in Physics

	Urban (N = 206)				Rural (N = 155)							
Item No.	SC f(%)	PU f(%)	AC f(%)	NC f(%)	SC f(%)	PU f(%)	AC f(%)	NC f(%)	χ^2	df	p-value	Dec
1	6(2.9)	36(17.5)	46(22.3)	118(57.3)	5(3.2)	14(9.0)	65(41.9)	71(45.8)	17.863	3	0.000	S
2	11(5.3)	20(9.7)	65(31.6)	110(53.4)	2(1.3)	14(9.0)	35(22.6)	104(67.1)	9.441	3	0.024	S
3	7(3.4)	15(7.3)	42(20.4)	142(68.9)	2(1.3)	10(6.5)	20(12.9)	123(79.4)	5.858	3	0.119	NS
4	4(1.9)	7(3.4)	34(16.5)	161(78.2)	6(3.9)	5(3.2)	5(3.2)	139(89.7)	17.046	3	0.001	S
5	4(1.9)	11(5.3)	47(22.8)	144(69.9)	2(1.3)	8(5.2)	17(11.0)	128(82.6)	9.121	3	0.028	S
6	5(2.4)	17(8.3)	43(20.9)	141(68.4)	0(0.0)	4(2.6)	14(9.0)	137(88.4)	21.075	3	0.000	S
7	4(1.9)	8(3.9)	58(28.2)	136(66.0)	2(1.3)	4(2.6)	30(19.4)	119(76.8)	4.936	3	0.177	NS
8	3(1.5)	10(4.9)	38(18.4)	155(75.2)	1(0.6)	5(3.2)	18(11.6)	131(84.5)	4.713	3	0.194	NS
9	12(5.8)	8(3.9)	16(7.8)	170(82.5)	3(1.9)	3(1.9)	10(6.5)	139(89.7)	5.063	3	0.167	NS
10	11(5.3)	22(10.7)	28(13.6)	145(70.4)	2(1.3)	7(4.5)	12(7.7)	134(86.5)	13.895	3	0.003	S
11	11(5.3)	26(12.6)	30(14.6)	139(67.5)	3(1.9)	6(3.9)	23(14.8)	123(79.4)	12.008	3	0.007	S
12	7(3.4)	22(10.7)	19(9.2)	158(76.7)	4(2.6)	1(0.6)	25(16.1)	125(80.6)	17.809	3	0.000	S
13	8(3.9)	8(3.9)	11(5.3)	179(86.9)	3(1.9)	1(0.6)	7(4.5)	144(92.9)	5.299	3	0.151	NS
14	15(7.3)	5(2.4)	17(8.3)	169(82.0)	0(0.0)	2(1.3)	7(4.5)	146(94.2)	15.231	3	0.002	S

15	12(5.8)	11(5.3)	10(4.9)	173(84.0)	2(1.3)	2(1.3)	6(3.9)	145(93.5)	9.830	3	0.020	S
16	11(5.3)	17(8.3)	9(4.4)	169(82.0)	1(0.6)	5(3.2)	7(4.5)	142(91.6)	10.477	3	0.015	S
17	2(1.0)	8(3.9)	54(26.2)	142(68.9)	3(1.9)	8(5.2)	17(11.0)	127(81.9)	13.380	3	0.004	S
18	8(3.9)	14(6.8)	26(12.6)	158(76.7)	1(0.6)	16(10.3)	24(15.5)	114(73.5)	5.684	3	0.128	NS
Over-all	**8(3.7)**	**15(7.1)**	**33(16.0)**	**150(73.05)**	**2(1.4)**	**6(4.1)**	**19(12.2)**	**128(82.1)**				

Note: n= Number of Respondent; NC= No Conception; AC= Alternative Conception; PU= Partial Understanding; SC= Sound/Scientific Conception; f= Frequency; %= Percentage; χ^2= Chi-Square; p-value= Probability value; df= Degree of freedom

Table 3 reveals the frequency, percentage and chi-square analysis of students' conception of laws of conservation of energy and momentum in physics by location. The result reveals that most students from urban and rural schools exhibited low levels of conceptual understanding of laws of energy and momentum. This was because No Conception (NC) was the most dominant category across all items, ranging from 110% (Item 2) to as high as 179% (Item 13) for students in urban schools, while that of rural schools were 11% (Item 2) to as high as 146 (Item 14). The table also indicate that PU, AC and NC are high for urban and rural students. Thus, few students from both urban and rural schools have SC of laws of conservation of energy and momentum in senior secondary school physics. It was also revealed in the table that overall f (%) of urban students that have SC-8(3.7%); PU-15(7.1%); AC-33(16.0%) and NC-150(73.5%). For rural students 2(1.4%) have SC; 6(4.1%) have PU; 19(12.2%) have AC and 128(82.1%) have NC. This means that both urban and rural students have highest frequency on NC which is naive understanding of laws of conservation of energy and momentum concept. NC is followed by AC, and PU which have low frequency. Nevertheless, the lowest frequency is indicated at the SC level. Thus, urban and rural students' conception of laws of conservation of energy and momentum concept is low and not scientific. This highlights a critical gap in physics education, suggesting that many learners struggle to internalize fundamental principles of laws of energy and momentum regardless of their school location. However, the chart (figure 2) below revealed distribution of urban and rural students' conceptions on laws of conservation of energy and momentum concept.

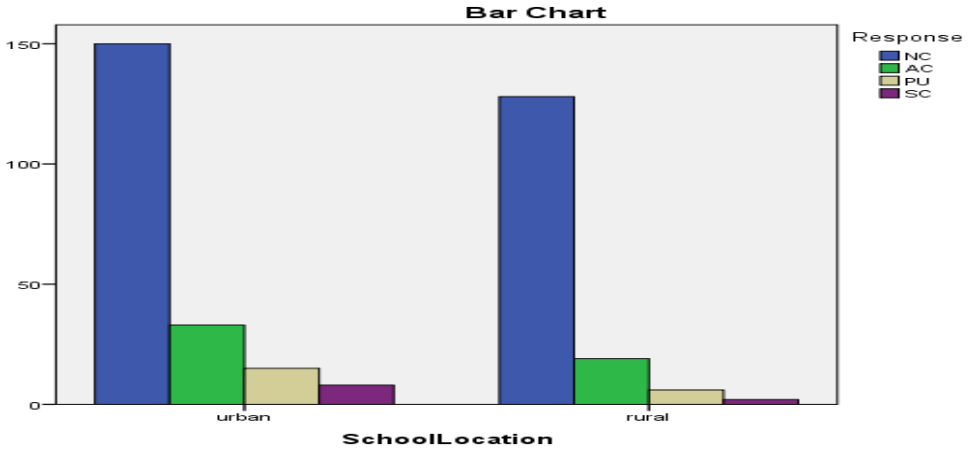

Fig.4: Histogram Showing the Distribution of Urban and Rural Students' Overall Understanding on Conception Test on Laws of Conservation of Energy and Momentum (CTLCEM)

The chart has its tallest and smallest bar in both gender (urban and rural) which is NC and SC respectively. This shows that both urban and rural students do not have the required conception of laws of

conservation of energy and momentum since SC has the smallest bar while NC has the tallest bar. Besides, the influence of location on students' conception of laws of conservation of energy and momentum concept was further investigated by testing the hypothesis below.

Table 4: Overall Trace Analysis of Influence of Location on Students' Conception of Laws of Conservation of Energy and momentum in Senior Secondary School Physics

		Students' Conceptual Levels				Total	χ^2	Df	p-value	Decision
		SC	PU	AC	NC					
School Location	Urban	8	15	33	150	206	5.880	3	0.118	NS
	Rural	2	6	19	128	155				
	Total	**10**	**21**	**52**	**278**	**361**				

Note: NC= No Conception; AC= Alternative Conception; PU= Partial Understanding; SC= Sound/Scientific Conception; NS= Not Significant; χ^2= Chi-Square; p-value= Probability value; df= Degree of freedom

The result presented in Table 4, shows the result on influence of school location on students' conception of laws of conservation of energy and momentum. The probability value (0.118) is greater than the level of significance (0.05). This gave the decision that the hypothesis is NS (Not Significant), thus, the null hypothesis was not rejected by the researcher. This means that students' conception of laws of conservation of energy and momentum in senior secondary school physics is not significantly influenced by school location.

Conclusion

Based on the finding of the study and discussions that followed, the following conclusion were made: urban and rural students' conception of laws of conservation of energy and momentum is not scientific. Also, students' conception of laws of conservation of energy and momentum is low based on their gender. It was further revealed that gender and location have no significant influence on students' conceptions of laws of conservation of energy and momentum in senior secondary school physics.

Discussion

The finding of the study shows that both male and female students do not have the required conception of laws of conservation of energy and momentum. Further analysis indicated that gender (that is male and female students) have no significant influence on students' conceptions of laws of conservation of energy and momentum in senior secondary school physics. This means that both male and female students possess no conception (NC) of laws of conservation of energy and momentum. Thus, male and female students' conception of laws of conservation of energy and momentum is not scientific or sound. Therefore, regardless of whether students are male or female, they demonstrate similar levels of understanding regarding the concept of laws of conservation of energy and momentum. This could be due to students existing in the same conceptual world. The finding of this study is in alignment with that of Ugwuanyi, Madu and Nduji (2024), Okeke (2022), Ani, Adonu and Madu (2019), Nduji (2019), Orji and Zudonu (2017). This is because Ugwuanyi, Madu and Nduji's study revealed that both male and female students did not attain the required level of scientific literacy in physics. Similarly, Okeke's investigation revealed that there is no significant influence of gender on the students' conceptual understanding of mechanical energy. Ani, Adonu and Madu on the other hand showed that gender is not significant on student's conceptual change in light waves. Nduji's study unveiled that student' conceptions of heat energy in senior secondary school physics is not significantly influenced by gender. Orji and Zudonu's investigation showed that students' conception of energy among science students is not significantly influenced by gender.

The finding of the study shows that school location (that is urban and rural) have no significant influence on students' conceptions of laws of conservation of energy and momentum in senior secondary school physics. This means that the differences in mean conceptual understanding scores between urban and rural students were too small to be considered meaningful. Thus, the geographical location of a school, whether it is situated in an urban or rural area, does not have a noticeable impact on students' understanding or conceptualization of the laws of conservation of energy and momentum in their physics education. This indicates a gap in non-uniformity in; curriculum, teaching practices, access to resources, and student background factors across geographical

location of schools. The finding of this study is in line with that of Nduji and Madu (2020) whose study revealed that school location has no significant influence on students' conceptions of heat energy in senior secondary school physics. Besides, finding of the present study is not in agreement with that of Ngbede (2019) whose result showed that location has a significant influence on students' levels of conceptions in group (3) out of the six groups. Similarly, Schubert and Wrenger (2016) whose study revealed that the conception of students about deserts being just sandy deserts is strongly connected with the subject-specific correctness of the conceptions regarding the location and formation of deserts, is not in consonance with the finding of the present study.

Contributions to Knowledge

Since the problem of no conception of conservation of energy and momentum affects both genders, thus, it is not a gender-gap issue. Rather, it is an indication that the current physics instruction, textbooks, or laboratory activities are not effectively promoting correct conceptual understanding. Hence, teachers and curriculum planners need to revisit how the concept of conservation of energy and momentum is introduced and taught in the classroom. This can be done by incorporating more inquiry-based experiments, real-life demonstrations, and conceptual discussions in their classroom lessons instead of relying only on formulas. Also, the teachers need to use everyday contexts like traffic collisions, sports, renewable energy to make the laws of conservation of energy and momentum which often sounds abstract to students, look tangible.

Recommendations

1. Physics teachers should endeavor to find out the preconceived notions of both male and female students in every instruction and resolve it in the course of teaching.
2. School management in synergy with the government should ensure that different workshops and seminars are organized for physics teachers on ways to enhance their students' conceptual level in physics, irrespective of their school location.

References

Abubakar, S. (2017). Role of Physics education for technological development for employment and self-productivity in Nigeria. *Journal of Educational and Social Research, 2*(10), 2239-978x.

Aderonmu, T. S. B., & Obafemi, D. T. A. (2015). Ordeals of Physics instruction in Nigerian secondary schools: way forward for the attainment of global competiveness. *Journal of Education and Practice, 6*(20), 1222-1235.

Agbele, A. T., Oyelade, E. A. & Oluwatuyi, V. S. (2020). Assessment of students' performance in Physics using two teaching techniques. *International Journal of Research and Scientific Innovation, 7*(7), 55-59.

Ahiakwo, M. J., & Isiguzo, C. Q. (2015). Students' conceptions and misconceptions in chemical kinetics in Port Harcourt metropolis of Nigeria. *African Journal of Chemical Education, 5*(2), 112-130.

Ajayi, V. O. (2017). Misconception. https://researchgate.net/publication/320172303_Misconc

Albert, O. (2024). Impulse and momentum: Explanation and examples. https://www.albert.io/blog/impulse-and-momentum/

Alonzo, S. M. D., & Mistades, V. M. (2021). Students' conceptual understanding and problem-solving of the work-energy and impulse-momentum theorems in a flipped classroom. *Journal of Physics: Conference Series*, 1882(1), 120–130.

Alordiah, C. O., Akpadaka, G., & Oviogbodu, C. O. (2015). The influence of gender, school location and socio-economic status on students' academic achievement in Mathematics. *Journal of Education and Practice*, *6*(17), 130-136.

Alrasheed, S. (2019). Impulse, momentum and collisions. Principles of mechanics. *Advances in Science, Technology & Innovation, 17,* 7385. https://www.doi.org/10/1007/978-3-030-15195-95

Ambusaidi, A. K., & Al Sabri, R. M. (2017). The impact of teaching physics via modeling on modifying alternative conception of energy and momentum conservation among 11th grade female students. *Journal of Educational and Psychological Studies [JEPS]*, *11*(1), 53-70.

Ani, J. O., Adonu, I. I. & Madu, B. C. (2019). Effect of concept mapping instructional strategy on students' conceptual change in Physics. *Asian Journal of Education and Social Studies, 5*(4), 1-7.

Atsuwe, B. A., & Mtoh T. T. (2019). Effect of cognitive style on student's achievement and Retention in Physics in senior secondary school in Giver-West Local Government Area, Benue state, Nigeria. *International Journal of Advance Research and Innovation*, *7*(2), 2347-3258.

Baran, M. (2016). Gender differences in high school students' interests in physics. *Asian-Pacific Forum on Science Learning and Teaching, 17*(6), 123-137.

Britanica.com. (2021). Conservation law. Retrieved from [Weblog post] https://www.britannica.com/science/conservation-law

Brundage, M. J., Maries, A., & Singh, C. (2023). Using the energy and momentum conceptual survey to investigate progression in student understanding from introductory to advanced levels. https://arxiv.org/pdf/2311.17054

Dalaklioglu, S., Demirci, N., & Sekercioglu, A. (2015) eleventh grade students' difficulties and misconceptions about energy and momentum concepts. *International Journal on New Trends in Education and Their Implications, 6*(1), 1309-6249.

Duda, H.J. (2020). Students' misconception in concept of Biology cell. *Anatolian Journal of Education*, *5*(1), 47-52.

Englund, C., Olofsson, A. D., & Price, L. (2017). Teaching with technology in higher education: understanding conceptual change and development in practice. *Higher Education Research & Development*, *36*(1), 73-87.

Eraikhuemen, L. & Ogumogu, A.E. (2014). An assessment of secondary school Physics teachers conceptual understanding of force and motion in Edo south senatorial district. *Academic Research International, 5*(1), 253-267.

Erdal, T. & Münir, O. (2017). Students' misunderstandings about the energy conservation principle: A general view to studies in Literature. *International Journal of Environmental & Science Education, 2*(3), 79 – 86.

Erinosho, S.Y. (2017). How do students perceive the difficulty of Physics in secondary school? An Exploratory Study in Nigeria. *International Journal for Cross-Disciplinary Subjects in Education, 3*(3), 1510-1516.

Eshetu, F. & Alemu, M. (2018). Students' conception of voltage and resistance concepts after conventional instruction. *Eurasia Journal of Mathematics Science and Technology Education, 14*(7), 3021 – 3033. https://doi.org/10.29333/ejmste/91603

Ezechi, N. & Adukwu, B.C. (2018). Practical activities for effective teaching of Biology: an issue for students' academic performance and sustainable national development. *Scholars Academic Journal of Biosciences (SAJB), 8*(4), 585-588. https://doi.org/10.21276/sajb.2018.6.8.4

Halliday, D., Walker, J., & Resnick, R. (2023). *Principles of physics*. John Wiley & Sons.

Hidayat, M. M, Agus, M.D., Yolviansyah, F., Octavia, R., & Iqbal, M. (2022). How critical thinking influence misconception in electric field. *International Journal of Educational Methodology, 21*, 187-199.

Holman, Stuart-Fox, D., & Hauser. C.E. (2018). The gender gap in science: How long until women are equally represented? *PLOS Biology*, *16*(4), 81-95. https://doi.org/10.1371/journal.Pbio.2004956.

Maudlin, T., Okon, E. & Sudarsky, D. (2020). On the status of conservation laws in physics: Implications for semiclassical gravity. *Studies in History and Philosophy of Modern Physics*, *69*, 67-81.

Mchunu, S., & Imenda, S. N. (2018). The alternative conceptions held by high school students in mechanics. *The International Journal of Science and Society, 4*(1), 25-42. https://www.doi.org/10.18848/1836-6236/CGP/v04i01/51358

Mengs, G. (2023). Laws of conservation of energy. https://energyeducation.ca/encyclopedia/Law_of_conservation_of_energy

Navaneedhan, C. G. (2017). What is meant by cognitive structures? How does it influence teaching - learning psychology? *IRA International Journal of Education and Multidisciplinary Studies, 7*(2), 89-98. https://doi.org/10.21013/jems.v7.n2.p5

Nduji, C. C. (2019). *Students' conceptions of heat energy in senior secondary school Physics* (Unpublished M.Ed. Thesis). University of Nigeria Nsukka, Enugu State, Nigeria.

Nduji, C. C., & Madu, B. C. (2020). Influence of gender and location on students' conceptions of heat energy in senior secondary school Physics. *British Journal of Education, 8*(6), 1-17.

Nduji, C. C., Onuyah, C. C., Madu, B. C., & Okeke, U.M. (2022). Students' conception of heat energy in senior secondary school Physics. *International Journal of Humanities and Social Studies 10*(1) 43-52

Okeke, C. S. (2024). *Students conceptions of laws of conservation of energy and momentum in senior secondary physics* (An Unpublished MEd Project). University of Nigeria, Nsukka, Enugu State, Nigeria.

Okeke, U. M. (2022). *Critical thinking skills as predictors of students' conceptual understanding of mechanical energy in senior secondary* (An Unpublished MEd Project). University of Nigeria, Nsukka, Enugu State, Nigeria.

Omilani, N. A., & Anifowose, H. (2022). Misconception interventions and pupils' conceptual change in selected concepts in basic science in Abeokuta. *International Online Journal of Primary Education (IOJPE), 11*(1), 154-167. https://doi.org/10.55020/iojpe.1102669

Osadebe, P.U. & Oghomena, D. (2018). Assessment of gender, location, and socio-economic status on students' performance in senior secondary certificate examination in Mathematics. *International Education Studies, 11*(8), 201-213.

Pika, N. J. (2017). Teaching the principle of conservation of mechanical energy using a conceptual change approach. https://pubmed.ncbi.nlm.nih.gov/27500587/

Reddy, M. V. B., & Panacharoensawad, B. (2017). Students problem-solving difficulties and implications in Physics: An empirical study on influencing factors. *Journal of Education and Practice*, *8*(14), 59-62.

Ugwuanyi, S.E., Madu, B.C. & Nduji, C.C. (2024). Assessing levels of scientific literacy among final year Physics students in colleges of education in the southeast zone of Nigeria. *African Journal of Science, Technology and Mathematics Education (AJSTME), 10*(4), 562-568.

Wangdi, D., Kanthang, P., & Precharattana M. (2017). Development of a hands-on model embedded with guided inquiry laboratory to enhance students understanding of law of mechanical energy conservation. *Asia-pacific Forum on Science Learning and Teaching, 18*(2), 212-228.

Wanning, C. J. (2018). Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education Programs, 5*(1), 61790-4560.

West African Examination Council (2021-2023). Chief examiners' report (Nigeria), senior school certificate examination, (May/June). https://www.waeconline.org.ng/e-learning/Physics/physmain.html

Woldeamanuel, Y. W., Abate N. T., & Berhane, D. E. (2020). Effectiveness of concept mapping-based teaching methods on grade eight students' conceptual understanding of photosynthesis at Ewket Fana primary school, Bahir Dar, Ethiopia. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(12), 1-16.