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Analyzing Gender Differences in Misconception in Linear Momentum Using Two-tier Diagnostic Test Instrument

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Abstract
Misconceptions that occur can vary between male and female students, therefore, the study analyzed gender difference in misconceptions in linear momentum. The diagnostic- descriptive research method was used in this study. A total of 70 (35 males and 35 females) first-year Senior High School students in the La-Nkwantanan Municipality were used for this study. Identification of misconceptions was conducted using the Two-tier multiple-choice diagnostic test instrument that was equipped with the Certainty of the Response Index method. The study showed both males' level of understanding and misconception (56.88%; 42.88%) and females (28.51%; 50.24%), respectively. Three research questions were raised and two research hypotheses were formulated and tested in this study. The data were analyzed using an independent sample t-test and the hypothesis were tested at 0.05 level of significance. The findings of the study revealed that male's students understanding of concept was statistically more [(18) = 0.003, $p < .05$] than females and misconception was found not be statistically significantly different [(18) = 0.285, $p > .05$]. The researchers recommend that physics teachers use cutting-edge pedagogical instructional techniques such as the use of two-tier diagnostic test instrument to maximize students' prior knowledge and uncover misconceptions.
Keywords: linear momentum, misconception, gender, tier-two, test, instrument
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1. Introduction

Through their daily life experiences, students grow up with ideas and opinions about the natural world. Tüysüz (2009) indicated that informal teaching, the language that is commonly used in everyday life, cultural backgrounds, and peer groups, seem to inculcate into students' unique conceptions that are substantially different from those in the physics syllabus and are frequently deep-rooted, instruction-resistant barriers to the acquisition of scientific concepts, and they persist even after instruction (Mustami, 2016).

In addition, Chiu (2007) also revealed that students bring a complex range of alternate conceptions about natural objects and phenomena to the formal science classroom, which relates to age, ability, gender, culture, daily life, and vocabulary commonly used to express public understanding of science. According to Diyanahesa, Kusairi, and Latifah (2017), such conceptions differ from those held by the scientific community, which students believe to be accurate and use them to their advantage consistently. These authors observed that these conceptions are not as a result of ignorance or a lack of information, but rather of a poor or insufficient understanding of a concept.

On the other hand, according to Appiah-Twumasi, Nti, Acheampong, and Ameyaw (2021), students' conceptions (non-scientific views) about a particular topic are primarily brought on by their ignorance of the issue, which is based on prior experiences. These non-scientific beliefs occur when the learner's prior knowledge required for processing new information is not adequately stated due to inadequate bridging, confusion, and poor reasoning (Hanson, Sam & Antwi, 2012).

Students in Senior High School are expected to meet their full learning potential in terms of increasing their conceptual knowledge and creative thinking abilities by examining concepts that arise in their daily lives using the proper physics ideas (Appiah-Twumasi et al., 2021). Theses authors indicated that occasionally, students' prior knowledge gets in the way of formally acquiring physics principles. As a result, physics concepts are explained in an improper way. For instance, students' difficulties understanding the principles and concepts of linear momentum have led to misconceptions regarding linear momentum that must be identified and corrected using an efficient diagnostic method.

According to Kanli (2015), the two-tier tests have been proven to be an effective tool used in the determination of student's conceptual understanding. In Kanli's explanation, the first tier of two-tier tests consists of a multiple-choice question regarding the concept, while the second tier consists of a question about the reason for the first-tier answer (Bayrak, 2013). The guidelines for developing the two-tier multiple-choice diagnostic instrument used in this study specify that if both tiers are accurately answered, as described by Tüysüz (2009), then the two-tiered question is regarded as correct. In this instrument, the first-tier of each item consists of a content question with a true or false option, and in the second-tier, students must justify their choice in tier one. This will, as a result, reduce students' chances of guessing the correct answer. According to Chiu (2007), misconceptions, alternate conceptions, alternative frameworks, children's ideas, and pre-scientific conceptions are some of the words used to describe student beliefs. However, because using so many distinct terminologies may cause readers to become confused, this study will present its findings of the misconception of students' using the term 'students' misconception'.

1.1 Statement of the Problem

Learning and students' performance in educational settings can be affected by diverse factors such as school environment, teachers, students and assessment methods. Students' misconceptions cannot be disregarded because they have an impact on their performance in all areas of education. For instance, in their studies, Etobro and Banjoko (2017) revealed that misconceptions in science education have become a focal point of discussion by researchers. These authors maintained that studies have shown that learners have difficulty in understanding science subjects especially physics and the difficulty of the students in these subjects create a significant challenge to learn the next level.

In Ghana a lot of students consider physics to be difficult and challenging and unattractive. This has led to the development of negative attitudes towards the subject. Due to its abstract nature, linear momentum, one of the most important domains in physics, is particularly regarded as difficult. Because of this, students have misconceptions about linear momentum, which have an impact on their conceptualization of and use of the concept in real-world situations. Etobro and Banjoko (2017) revealed recent studies on students' conceptual understanding of fundamental concepts in physics have indicated that new concepts can hardly be learned unless the existing misconceptions are identified and corrected.

Different studies on students' conceptual understanding of science have been conducted and several instructional strategies (such as concept mapping, interviews, and multiple-choice diagnostic instruments) for conceptual change have been provided. However, there appears to be persisting misconceptions even after being treated by those suggested instructional strategies. The study therefore, was set out to identify, using two-tier diagnostic test instrument to analyse gender differences in misconception in linear momentum in the research region in the Ayawaso and Madina-La Nkwatanan Municipalities

2. Review of Related Literature

2.1 Types of Misconception

Misconception, according to Seo et al. (2017) can be categorized into five types namely, preconceived notions, non-scientific beliefs of conceptual misunderstandings, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions

2.2 Preconceived notions

Preconceived notions are widespread theories based on personal experience and life experiences (Murdoch, 2018). For example, many people believe that how big or small an object is, determines its momentum regardless of its state of motioned. Students' life experiences interfere with their ability to understand science, according to studies conducted in Ghana and Nigeria by Mohammed (2016).

2.3 Non-scientific beliefs

Students' non-scientific views are their opinions or knowledge gained from sources other than scientific sources (Leaper et al., 2012). For example, some science students believe that the greater the momentum of an object, the greater its kinetic energy. Again, participants were of the view that there is no bearing between momentum and energy. Such misconceptions and many others are common among students from different countries, backgrounds, and educational levels and are deeply held in the students' cognitive structure (Mbonyiryivuze, Yadav & Amadalo, 2019).

2.4 Conceptual misunderstandings

Morais (2013) remarked conceptual misunderstandings occur when students develop their own confusion and incorrect ideas based on correct scientific concepts. Ross (2019) also stated that conceptual misunderstandings occur when students are taught scientific information in a way that does not force them to confront paradoxes and conflicts arising from their own preconceived notions and non-scientific ideas. For example, momentum can be thought of as mass in constant motion. Appiah-Twumasi et al. (2021) explained that conceptual difficulties arise because some concepts are not directly linked to experience. Such concepts are constructs and, therefore, non-intuitive. Students may fail to recognize the limitations of applying an idea or law, and as a result, they overgeneralize.

2.5 Vernacular Misconceptions

According to Keeley (2012), vernacular misconceptions are related to the use of words whose general meaning is different from the meaning accepted in the world of science; For example, many students commonly use the word momentum to refer to energy in everyday speech because they believe momentum is a form energy. Pathare and Pradhan as cited in Appiah-Twumasi et al. (2021) observed that student-teachers develop alternate notions about phenomenon as a result of their regular interactions and conversations with peers. Moreso, these authors indicated that in scientific language, a word/phrase that implies one thing in everyday speech may signify something quite different.

2.6 Factual Misconceptions

Factual misconceptions as explained by Soeharto et al. (2019), are misunderstandings that are developed early in life and last into adulthood. Also, factual misconceptions are falsities often learned at an early age and retained unchallenged into adulthood (Ross, 2019). Students believe, for example, that the forces exerted by two colliding objects will vary based on their masses.

2.7 Empirical Studies on Gender-related Concepts in Physics

Students' emotions and behaviour, as well as their physical appearance, show gender variances. It appears boys and girls are treated differently at home and in school, which can impact their gender roles, identities, academic development, and specifically learning physics. According to Awan, Khan, and Aslam (2012), the teaching and learning of physics concepts are marked by gender discrepancy and it is beneficial to learn the differences between males and females to find out if the gender disparities in education can be traced back to differences in biology or nature, or social/nurture influences. Physics, by its very nature, is a highly conceptual subject, whereas much may be learned by rote in a meaningless manner. Even though students show some signs of learning and comprehension in their examination, Awan, Khan, and Aslam (2012) revealed misconceptions of some basic physics concepts in some regions. For example, a study conducted by Appiah-Twumasi et al. (2021) to examine students' misconceptions in the heat and temperature concept test (HTCT) intimated that gender affected students' perceptions of heat and temperature concepts. That is students' gender interactions influence students' misconceptions about heat and temperature concepts.

In a similar study, Dalaklioğlu, Demirci, and Şekercioğlu (2015) observed the development of 549 students' understanding of momentum with 20 conceptual questions. The questions used in their research were on the relationship between momentum, mass, and velocity. Other questions were on the conservation principle of momentum in two dimensions and the vector nature of momentum and impulse in one dimension. Their study findings revealed that study subjects were confused with the concepts and could not recognize relationships between momentum and impulse and the law of conservation of momentum. Also, Ültay and Alev (2017) studied conceptual level and misconceptions regarding impulse and momentum ideas of 89 primary science students and 124 high school students using an open-ended conceptual test relating to impulse and momentum concepts. Pre- and post-experimental designs were used. The study's findings revealed that both groups struggle with impulse and momentum ideas, and students' misconceptions remained the same even after the topic areas were taught. Ültay and Alev (2017).

Research like Awan et al. (2012) revealed that females are slightly better at holding scientific views. In contrast, males hold more misconceptions and concluded that females are equally well or sometimes even doing better than males in physics. However, Halpern et al. (2007) contend that there is a gap between the desire of males and females to observe common scientific phenomena, which as a result lead to a lack of experiences in science which ultimately leads to a lack of conceptual understanding of science, hence the misconception among males and females.

2.8 Research Questions

The research questions for the study were:

1. What are the difficulty level and misconceptions of males on linear momentum concepts (LMCT)?
2. What are the difficulty level and misconceptions of females in LMCT?
3. Is there any difference in understanding concepts (UC) between males and females in linear momentum?

The research questions raised two hypotheses as shown below:

Ho_1: There is no significant difference in understanding concept between males and females in LMCT

Ho_2: There is no significant difference in misconception between males and females in LMCT

3. Methodology

3.1 Research Design and Sample

The diagnostic-descriptive research approach was employed for the study. This is because it was ideal in identifying, analysing and describing the misconceptions SHS 1 student have in linear momentum. The target population for the study were first-year Senior High School students in the Ayawaso East and Madina-La Nkwantanan municipalities all in Greater Accra, Ghana. These municipalities were purposively sampled because these municipalities both have one Senior High School that is exclusively male. The study comprised 70 first-year Senior High School students (35 males and 35 females). This study was conducted to analyze and describe the misconceptions theses first-year Senior High School students' have in linear momentum. This is because linear momentum is about every activity that involves motion and it is an essential concept of physics. Students in Senior High School (SHS) one must have learned displacement, velocity, force, acceleration, energy as well as a variety of laws such as Newton's laws of motion. Inherently, these courses share many common misconceptions which extend to linear momentum.

3.2 Research Instruments and Data Analysis

Data for this study were collected using a two-tier multiple-choice diagnostic instrument. The items in two-tier multiple-choice diagnostic instruments are meant to identify alternate ideas and misunderstandings in a limited specified content area. Two-tier tests are a more advanced instrument than the others because they examine students' explanations and interpretations for their answers. Furthermore, two-tier assessments are reported to be valid and trustworthy tools that better evaluate student concepts and are simple to score and apply (Kılıç & Saglam, 2009).

The linear momentum concept test (LMCT) items were prepared to include the concepts used in the topic "linear momentum". The first tier of the diagnostic tests is a multiple (true-false) choice test. It consists of a question item or a premise called the stem and a set of options (true/false) one of which is the correct answer. In the second tier, students are given the opportunity to state with reason or explain why they selected a particular option in the tier-one. The researchers developed the two-tier multiple-choice diagnostic instrument (LMCT) to identify the misconceptions students might have concerning this topic. To develop this test, studies on the misconceptions concerning the topic "linear momentum" were examined. A total of 10 diagnostic questions were prepared. These questions were examined and validated by several physics' education experts and revised according to their suggestions

The LMCT instrument was field pilot-tested with second year students of West Africa Senior High School in Greater Accra. The LMCT was administered to the students by two physics tutors at different times. These tutors were well trained by the researchers and were asked to rate the questions item by item to determine its reliability. Kappa statistics was used to test the interrater reliability of the LMCT and was found to be 0.9 which indicated a perfect reliability.

4. Results and Discussions

Table 1: Structure of Linear Momentum Concept Test

S/N	Items	Tier-one True/False	Tier-two Explanation
1	An object with mass will have momentum		
2	An object has momentum only when it moves with a constant speed		
3	If an object has momentum, then it must also have mechanical energy		
4	If an object does not have momentum, then it does not have mechanical energy either.		
5	A less massive object can never have more momentum than a more massive object		
6	Forces cause change in momentum		
7	A truck driving along a highway road has a large quantity of momentum. If it moves at the same speed but has twice as much mass, its momentum is doubled.		
8	A tiny bullet can have more momentum than a huge truck		
9	Object A has more momentum than object B. Therefore, object A will also have more kinetic energy.		
10	A momentum is a form of energy		

*Total score of LMCT is 10 Marks.

Table 2: Criteria for Scoring the Two-tier Test Instrument

Score	Pattern of answers	Class level of understanding
1	The answer to tier one and two is correct	Understand concept
0	The answer to tier one is correct but to tier two is wrong	Misconception
0	The answer to tier one is wrong but to tier two is correct	Misconception
0	The answer to both tiers is wrong	Don't understand the concept
0	Answer tier-one either correct or wrong but leaves tier two blank	Don't understand the concept
0	Leave tier-one blank but answer tier two either correct or wrong	Don't understand the concept

1= Understand concept (UC) **0 = Misconception; Don't understand concept**

Table 2 shows a summary of how students were scored. If the answer to a particular item is correct on both tiers' students receive a mark of one, which indicates students understanding of the linear momentum concept. However, if the answer is incorrect on one or both tiers' students score zero. Nonetheless, if students leave a blank space on one or both tiers' it is considered incomplete and assumed that students do not understand the concept, hence a score of zero.

Table 3: Sstudents' Response and their Misconceptions

S/N	Items	T_1	T_2	Misconception
1	An object with mass will have momentum	[i]T	[w] Having mass gives an object momentum	Momentum depends largely on mass
2	An object has momentum only when it moves with a constant speed	* F	[w]The object has no mass	Momentum depends largely on mass
3	If an object has momentum, then it must also have mechanical energy	[i]F	[w] Energy is the ability to do work	Momentum and mechanical energy are not related
4	If an object does not have momentum, then it does not have mechanical energy either.	[i]T	[w]Momentum and mechanical energy are two different things	Momentum and mechanical energy are not related
5	A less massive object can never have more momentum than a more massive object	[i]T	[w]The mass of the object is small	Momentum depends largely on mass
6	Change in momentum depends on the force	* T	[w]Force and momentum are equal	Momentum depends largely on mass
7	Two objects of varying mass have the same momentum. The least massive of the two objects will have the greatest kinetic energy	[i]F	[w] The mass of the least massive object is small	Momentum depends largely on mass
8	A tiny bullet can have more momentum than a huge truck	[i]F	[w] Tiny bullet has small mass	Momentum depends largely on mass
9	Object A has more momentum than object B. Therefore, object A will also have more kinetic energy.	[i]T	[w] Object A has bigger mass than object B, hence, A will have more kinetic energy	The greater the mass the greater the momentum and the kinetic energy
10	Momentum is a form of energy	* F	* Energy is the ability to do work and momentum = mv	No misconception

Table 3 contains students' response to tiers-one and two (those indicating correct answers were marked as '* ' and incorrect answers denoted by '**i**') and their misconceptions.

Appiah-Twumasi et al. (2021) intimated that Senior High School students must achieve maximum learning goals in developing their conceptual understanding skills and thinking creatively by studying every problem that occurs in their life using appropriate physics concepts. However, in the case of Table 3 students' prior knowledge interferes with formalized learning of physics concepts. This results in inappropriate explanations of linear momentum concepts, as shown in Table 3. For example, from Table 3 students' difficulty in understanding the linear momentum concepts is a result of conception and misconceptions acquired and stored and has occurred without an ostensible link between everyday life and school experiences.

Table 4: Criteria for Concept Understanding in LMCT

Tier one	Tier two	CRI	Category	Scale (%)
Correct	Correct	High	UC	66 - 98
Incorrect	Correct	Fair	M	33 -65
Correct	Incorrect	Fair	M	
Incorrect	Incorrect	Low	DUC	0 -32

***UC**= Understand Concept, **M** =Misconception, **DUC**= Do not Understand Concept*

Table 4 measures the level of understanding of both male and female students in LMCT.

If students' level of understanding falls within the range of 66%-98%, then it implies that students have a high understanding of the concept of linear momentum, in which case students must have both tiers correct. Similarly, students will be considered as having a fair understanding of the concept when they get either tier one correct or wrong. This shows the misconception (M) students have on LMCT with a percentage range of 33-65. Lastly, students will fall into the 'DUC' (Do not Understand Concept) category and will be classified as having a low understanding of LMCT when found within the of 0 – 32.

Research Question One: *What are the difficulty level and misconception of males on linear momentum concepts?*

Table 5: Percentage of Male Students' Level of Understanding of LMCT

Q	UC	%	M	%	DUC	%
1	11	31.4	24	68.6	0	0.0
2	12	34.3	22	62.9	1	2.9
3	14	40.0	21	60.0	0	0.0
4	15	42.9	20	57.1	0	0.0
5	15	42.9	20	57.1	0	0.0
6	22	62.9	13	37.1	0	0.0
7	28	80.0	07	20.4	0	0.0
8	31	88.6	04	11.4	0	0.0
9	29	82.9	06	17.1	0	0.0
10	22	62.9	13	37.1	0	0.0

***UC**= understand concept, **M**= misconception, **DUC**= Do not Understand Concept*

Descriptive statistics of percentages (in Table 5) were used to analyze male students' level of understanding and misconception in the linear momentum concept test. Table (5) also shows the 'DUC' level of male students. The majority of the male students demonstrated their understanding of the concept (UC). This means that they answered both tiers one and two (T_1 &T_2) correctly as shown in Table 5. Questions 1 – 5 recorded the least percentage of students (31.4% - 42.9%) who showed understanding of the concept. A very high percentage of male students also showed understanding of the concept in questions 6, 7, 9, and 8 (62.9%, 80.0%, 82.9% & 88.6) respectively as shown in Table 5.

A greater percentage of male students either had the answer to tier-one correct but tier two wrong or tier one wrong but tier two correct. This indicates the misconception (M) male students had. Questions 1-5 recorded the highest percentage of misconception (57.1% - 68.6%) while questions 6-10 recorded the least percentage of misconception (11.4% - 37.1%). Question 2 recorded 2.9% of 'DUC' (Do not Understand Concept). This implies that students had answers to both tiers wrong or answer tier-one either correct or wrong but leaves tier two blank or leave tier-one blank but answer tier two either correct or wrong.

Table 6: Summary of Male Students' Level of Understanding of LMCT

Level of understanding	**Percentage (%)**
Understanding concept	56.88
Misconception	42.88
Don't understand concept	0.29

Male students' understanding of the concept of linear momentum was found to be 56.88% as shown in Table 6. This suggests that male students had a fair understanding of concepts in linear momentum as indicated in Table 4. Further, the misconception of male students on LMCT was recorded to be 42.88% (Table 6) which was also categorised as fair in Table 4 with a percentage range of 31 – 61. The percentage of male students who do not understand LMCT was found to be 0.29% (Table 6.0) which means that 0.29% of the male students' population had low (0%-32%) understanding of LMCT and therefore do not understand the concept.

Research Question Two: *What are the difficulty level and misconceptions of females on linear momentum concepts?*

Percentages presented in Table 5 were used to assess students' difficulty level and misconceptions of females on linear momentum concepts.

Table 7: Percentage of Female Students' Level of Understanding of LMCT

Q	UC	%	M	%	DUC	%
1	05	14.3	18	51.4	12	34.3
2	11	31.4	08	22.4	16	45.7
3	12	34.3	10	28.6	13	37.1
4	10	28.6	12	34.3	13	37.1
5	06	17.1	11	31.4	18	51.4
6	06	17.1	28	80.0	01	2.9
7	17	48.6	18	51.4	00	0.0
8	16	45.7	19	54.3	00	0.0
9	15	42.9	19	54.3	01	2.9
10	02	5.7	33	94.3	00	0.0

UC*= understand concept*, ***M****= misconception*, ***DUC****= Do not Understand Concept*

Table 7 analyses female students' level of understanding of LMCT based on their 'UC' (understanding of the concept), 'M' (misconception), and 'DUC' (do not understand the concept) using descriptive statistics of percentages. The highest percentage (42.9% - 48.6%) who had both tiers correct was recorded in questions 7, 8, and 9. Following were questions 4, 2, and 3 with percentages of 28.6, 31.4, and 34.3 respectively. The least percentage (5.7% - 17.1%) of female students who had both tiers correct was recorded in questions 10, 1, 5, and 6 respectively. Very high percentages (22.4% - 94.3%) were recorded for students who had either tier one correct or wrong or vice versa for various questions. 'Do not understand the concept' (DUC) also attracted quite a high percentage (0% - 51%).

Table 8: Summary of Female Students' Level of Understanding of LMCT

Level of understanding	**Percentage (%)**
Understanding concept	28.57
Misconception	50.24
Don't understand concept	21.14

A summary of female students' level of understanding from Table 8 indicates that 28.57% of the students understood the concept. This implies that very few female students understood LMCT. This percentage (28.57%) falls within a scale of 0% - 32% on Table 4 and it indicates that the understanding of the concept (UC) by the female students in LMCT was low. Again, misconception of female students on LMCT, on the other hand, was indicated to have recorded the highest percentage (50.24%) from Table 8 and according to the certainty of response index in Table 4, it was classified as fair with a percentage range of 33% - 65%. 'Do not understand the concept' (DUC) on Table 8.0 recorded 21.14% of female students. Though quite low, its implication, per the certainty of response index on Table 4 suggests that (21.14%) female students had a low understanding of LMCT. Thus far, descriptive analysis from Tables 7 and 8, vis-à-vis Table 4.0 indicates that there are gender differences in understanding concepts and misconception in LMCT.

Research Question Three: *Is there any difference in understanding concepts (UC) between males and females in linear momentum?*

Table 9: Independent Sample t-test for Males and Females in Understanding Concept (UC)

	Gender	**N**	**Mean**	**SD**	**t**	**df**	**Sig(2-tailed)**
UC	Male	10	19.9000	7.48999	3.450	18	0.003
	Female	10	10.0000	5.12076			
M	Male	10	15.0000	7.37865	-1.101	18	0.285
	Female	10	18.6000	7.24492			

UC*=understanding concept,* ***M****= misconception*

The independent sample t-test (Table 9) revealed there is significant difference in understanding concept [(18) = 0.003, $p < .05$] between male and female students. Hence, the null hypothesis (**Ho_1**) was rejected. However, the misconception was not significantly different [(18) = 0.285, $p > .05$] between male and female students, hence the null hypothesis (**Ho_2**) was retained as indicated in Table 9.

5. Conclusion and Recommendation

The study investigates gender differences in linear momentum misconceptions. Linear momentum concept test (LMCT), a two-tier diagnostic test instrument with ten questions, was developed to explore students' misconceptions. Students' responses were categorized into three levels of comprehension: 'understand concept (UC), do not understand concept (DUC), and misconception (M).' According to the findings, male students had a statistically higher understanding of the concept than female students, and there was no statistically significant difference in misconceptions. The researchers suggest that physics teachers employ two-tier instruments to investigate their students' misconceptions about linear momentum concepts. The researchers also advise physics teachers to employ modern pedagogical instructional strategies to maximize students' prior knowledge and uncover misconceptions.

Reference

Aina, J. K., & Akintunde, Z. T. (2013). Analysis of gender performance in physics in colleges of education, Nigeria. *Journal of Education and practice, 4*(6), 1-5.

Appiah-Twumasi, E., Nti, D., Acheampong, R., & Ameyaw, F. (2021). Diagnostic assessment of students' misconception about heat and temperature through the use of TWO-TIER TEST . *Psychology, 4*(1), 90-104.

Awan, A., Khan, T., & Aslam, T. (2012). Gender disparity in misconceptions about the concept of solution at secondary level students in Pakistan. *Journal of Elementary Education, 22*(1), 65-79.

Babajide, O. J. (2012). In physics among senior secondary school students in Osun state, Nigeria. *Journal of Science, Technology, Mathematics and Education, 8*(2), 187-193.

Bayrak, B. K. (2013). Using Two-Tier Test to Identify primary students' conceptual understanding and alternative conceptions in acid base. *Online Submission, 3*(2), 19-26.

Buabeng, I., Ampiah, J. G., & Quarcoo-Nelson, R. (2012). senior high school female students' interest in physics as a course of study at the University level in Ghana. *Gender & Behaviour, 10*(1), 4574-4584.

Chiu, M. H. (2007). A national survey of students' conceptions of chemistry in Taiwan. *International Journal of Science Education, 29*(4), 421- 452.

Dalaklioğlu, S., Demirci, N., & Şekercioğlu, A. (2015). Eleventh grade students' difficulties and misconceptions about energy and momentum concepts. *International Journal of New Trends in Education and Their Implications, 6*(1), 13-21.

Diyanahesa, N. E. H., Kusairi, S., & Latifah, E. (2017). Development of misconception diagnostic test in momentum and impulse using isomorphic problem. *Journal of Physics: Theories and Applications, 1*(2), 145-156.

Etobro, A. B., & Banjoko, S. O. (2017). Misconceptions of genetics concepts among pre-service teachers. *Global Journal of Educational Research, 16*(2), 121-128.

Gok, T. (2012). The impact of peer instruction on college students' beliefs about physics and. *International Journal of Science and Mathematics Education, 10*(2), 417-436.

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological science in the public interest, 8*(1), 1-51.

Hanson, R., Sam, A., & Antwi, V. (2012). Misconceptions of undergraduate chemistry teachers about hybridisation. *African Journal of Educational Studies in Mathematics and Sciences, 10*, 45-54.

Kanli, U. Y. (2015). Using a two-tier test to analyse students' and teachers' alternative concepts in astronomy. *Science Education International, 26*(2), 148-165.

Keeley, P. (2012). Misunderstanding misconceptions. *Science Scope, 35*(8), 12-15.

Kılıç, D., & Sağlam, N. (2009). Development of a two-tier diagnostic test concerning genetics concepts: the study of validity and reliability. *Procedia-Social and Behavioral Sciences, 1*(1), 2685-2686.

Li, J. (2012). Improving students' understanding of electricity and magnetism. *Doctoral dissertation, University of Pittsburgh*.

Li, J., & Singh, C. (2017). Developing and validating a conceptual survey to assess introductory. *European Journal of Physics, 38*(2), 1-28.

Mbonyiryivuze, A., Yadav, L. L., & Amadalo, M. M. (2019). Students' conceptual understanding of electricity and magnetism and its implications. *A review. African Journal of Educational Studies in Mathematics and Sciences, 15*(2), 55-67.

Mohammed, B., Ahmed Emigilati, M., & Ishiaku, I. (2016). Comparative study of preconceived scientific ideas held by different groups of junior secondary school students in Niger State, Nigeria. *Journal of Education and Practice, 7*(16), 19-24.

Murdoch, J. (2018). Our preconceived notions of play need to challenging. *Early Years Educator, 19*(9), 22-24.

Mustami, M. K. (2016). Identifying the misconception in students' biology department on genetics concept with CRI method. *The Social Sciences, 11*(13), 3348-3351.

Raimi S.M & Adeoye F.A. (2006). Gender differences among College Students' as determinants of performance in Integrated Science. *African Journal of Educational Research, 8*(1&2), *41-49*, 41-49.

Research Clue. (2018). *Misconception in physics in senior secondary school.* [Online] Available:file:///C:/Users/Daniel/Desktop/tot%20cos%20phd/Research%20Clue.%20(2018).html (August 10, 2018)

Sadler, P. M., & Sonnert, G. (2016). Understanding misconceptions: Teaching and learning in middle school physical science. *American Educator, 40*(1), 26-32.

Seo, K., Park, S., & Choi, A. (2017). Science teachers' perceptions of and approaches towards students' misconceptions on photosynthesis: A comparison study between US and Korea. *Eurasia Journal of Mathematics Science and Technology Education, 13*(1), 269-296.

Soeharto, S., Csapó, B., Sarimanah, E., Dewi, F. I., & Sabri, T. (2019). A review of students' common misconceptions in science and their diagnostic assessment tools. *Jurnal Pendidikan IPA Indonesia, 8*(2), 247-266.

Tuysuz, C. (2009). Development of two-tier diagnostic instrument and assess students' understanding in chemistry. *Scientific Research and Essay, 4*(6)*,* 626-631.

Ültay, E., & Alev, N. (2017). Investigating the effect of the activities based on explanation assisted react strategy on learning impulse, momentum and collisions topics. *Journal of Education and Practice, 8*(7), 174-186.

Uwizeyimana, D., Yadav, L. L., Musengimana, T., & Uwamahoro, J. (2018). The impact of teaching approaches on effective physics learning: An investigation conducted in five secondary schools in Rusizi district, Rwanda. *Rwandan Journal of Education, 4*(2), 21-14.

Verkade, H., Mulhern, T. D., Lodge, J. M., Elliott, K., Cropper, S., Rubinstein, B., Horton, A., Elliott, C., Espiñosa, A., Dooley, L., Frankland, S., Mulder, R., & Livett, M. (2017). *Misconceptions as a trigger for enhancing student learning in higher education: A handbook for educators.* Melbourne: The University of Melbourne.

Villarino, G. N. (2015). Students' alternative conceptions and patterns of understanding on electric. *International Journal of Science and Research, 7*(3), 482-488.