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MISCONCEPTION INTERVENTIONS AND PUPILS' CONCEPTUAL CHANGE IN SELECTED CONCEPTS IN BASIC SCIENCE IN ABEOKUTA

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Abstract

This study determined the effect of misconceptions intervention on students' conceptual change in the concepts of density and floatation in basic science. The moderating effects of gender and school types on students' conceptual change in the selected concepts were also determined. The misconception interventions in this study are hands-on activities that allow students who engage in them to observe evidence that contradict their misconceptions in density and floatation. Students in the upper basic three were the population of the study. A two-tier multiple-choice test was used to measure the conceptual change. The result revealed that exposing upper basic three students to the misconception intervention is significantly effective in facilitating conceptual change in the selected concept in basic science.

Keywords: Misconceptions, basic science, learning outcome.

INTRODUCTION

A concept can be considered an idea, an object or an event that helps us understand the world around us (Eggen & Kauchak, 2004; Kampourakis, 2018). Teaching and learning science at any level involves changing learners' conceptions about certain phenomena to the conception of the scientific community about the idea or phenomenon (Yagbasan, 2003). However, it is unfortunate to realize that student misconceptions about different phenomena often stand in the way of instructions that could bring about conceptual change. Various studies have shown that the first step in conceptual change is diagnosing and challenging students' misconceptions. Unfortunately, the conventional lecture method of instruction has been found incapable when it comes to remediation of students' misconceptions (Brandriet & Bretz, 2014).

Several studies have attempted various misconception interventions to remediate students' misconceptions in various concepts in science. For example, Allen (2010) used misconception intervention to promote conceptual change of the concept of floatation and gravity among primary school students. Other examples include the studies of Ruth (1985) which determined the effect of science text on students' misconception in science; Zeidler and Mcintosh (1989), which revealed that using the laserdisc generated models on college students resulted in conceptual change; Chang and Barufaldi (2010) also determined the effect of the problem-solving-based instructional model in changing alternative framework of learners in earth science. Misconception intervention is profoundly effective in almost all educational experiments because it terminates self-doubt and brings about absolute cognitive resolution of the cognitive conflict the learner may have about the concept (Gooding & Metz, 2011).

It is known that after the conceptual change occurs, students do not restructure, replace, or abandon their misconceptions even though students happen to produce accurate answers (Potvin, 2013). This is because research in neuroeducation affirms that old ideas (misconception) and new ideas about the phenomenon coexist. The intervention only makes the learner correct cognitive decisions when confronted with a new situation about the phenomenon (Chi, 1991; Diut & Treagust, 2003; de Boer, Donker, & van der Werf, 2014).

Basic Science is the major science subject at the basic level of education in Nigeria; to make students: to be interested in science; take advantage of the numerous career opportunities offered by the study of science and technology, apply the basic scientific and technology skills and knowledge in meeting societal needs and; become prepared for further studies in science and technology (FRN, 2014). Therefore, the basic science and technology curriculum can be considered the foundation of science in Nigeria at the basic level (Danjuma, 2015). The basic science curriculum is one of the themes in nature with the following themes: you and environment, living and non-living things, you and technology and you and energy. The theme "you and energy" is a theme that involves physical science concepts such as weight, density, energy, to mention a few. This area has been established as a difficult area for many students (Martinez-Borreguero, Naranjo-Correa, Canada, Gomez, & Martins, 2018).

Research in basic science in Nigeria has been frequently directed towards determining the effect of various innovative strategies on students' learning outcomes. Examples of such innovative strategies include; Guided inquiry and Expository lectures (Adewale, Effiong, & Ekpo, 2015), Collaborative and Competitive learning strategies (Danjuma, 2015) and Computer simulation instruction (Ojo, 2020). Most of these experiments showed that the strategies improved students' achievement, interest, and attitude in basic science. Unfortunately, irrespective of the positive impact of research at this level and the excellent performance of students in basic science, students' performance in the senior secondary science subjects (biology, chemistry and physics) is very poor. Scholars like Adesoji (1994) have attributed this to poor science background in basic science, which ordinarily should be the foundation for secondary science. The shift in the focus of research on the teaching and learning of the subject has been limited to achievement because evidence has shown that students' achievement may improve even when their misconceptions persist (Taber, 2009; Omilani, 2015).

Perhaps, the unchallenged misconceptions in primary science that students carry over to senior secondary schools are responsible for poor performance in senior science. Also, misconceptions often defeat students' new thinking model from most novel teaching strategies (Potvin, 2013). This often results in the learners being unable to utilize the model as they fade away with time; because the misconceptions can resurrect even when they are presumed to be defeated if the right cognitive strategy is not employed to facilitate conceptual change (Potvin, 2013; Hewson & Hewson,1984).

Misconception intervention makes the learner see empirical evidence, which will remediate the learner's misconception. This intervention comes in various forms such as activation activity, think sheet, discussion strategies, to mention a few (Guzzeti, Synder, Glass, & Gamas, 1993). For example, Allen (2010) employed misconceptions interventions to correct learners' misconceptions due to expectation-related observation. According to Allen, expectation related observation is the biased collection or interpretation of data influenced by a desire to reach a predetermined conclusion. The misconception intervention of Allen (2010) adopted many of the elements of the White and Gunstone (1992)

Predict-Observe-Explain, which involves: finding out students' initial ideas, providing teachers with information about students' thinking, generating discussion, motivating students to want to explore the concept and generating investigation (Joyce, 2006). Misconception intervention in this current study is not deviating from the approach of POE and the misconception intervention of Allen (2010). The only minor deviation is that this study is not only interested in errors that make learners deliberately collect data that fits their expectations during practicals (Pine *et al.*, 2001). Most especially as it relates to learners reporting and interpreting data based on their bias, this study also used pupils' ideas as the starting point for the experiment designed to correct their misconceptions (Pine *et al.*, 2001). This study's additional focus is to guide pupils to desist from using the limited decision rules or faulty decision rules to interpret observation they make out of an experiment related to density and floatation.

According to Talanquer (2013), in the process of cognition, students will first create a mental representation, followed by associative thinking, analogical reasoning, and metaphorical linking, which invariably help us classify the entity or phenomenon as belonging to a specific category within or across knowledge domains. Talanquer (2013) further reiterates that decision rules are formed and help learners predict an object's behaviour when the object is involved in different processes or events. However, some learners often use only one decision rule for a specific task in a predetermined context, where they are supposed to use more than one decision rule. For example, the researcher found out in a study that is currently ongoing that many students in the primary school science class assume that when an object is divided into two, the object's mass, volume and density are reduced by half (Omilani, 2017). This assumption is based on a decision rule of the fraction. For example, half of the orange is half, which is the same for bread. This rule provides an accurate answer to mass and volume. However, the decision rule does not help learners provide accurate answers for density. Density is derived from the relationship between two fundamental concepts (mass and volume); hence, it is not reduced but remains constant irrespective of reducing an object size by half. Misconception interventions in the context of this study are practical activities deliberately designed to make students recognize the weaknesses and inadequacies of the decision rules they have been using. So as to make them adjust and adopt misconception free decision rules.

Theoretical Rationale

The theoretical framework that anchors this study is the conceptual change theory of learning science concepts propounded by Chi, Slotta and de Leeuw in 1994 (Chi, Slotta, & de Leeuw, 1994). This theory considers learning as the process of comprehending and accepting ideas because they are seen as intelligible and rational. Learning is thus a kind of inquiry. Therefore, the students must make a judgment based on the available evidence. Also, the theory posits that learning is concerned with ideas, their structure and evidence of them (Lee & Law, 2001). The theory is based on epistemological, metaphysical and psychological suppositions. The epistemological supposition is about the nature of ontological categories, which the learners use to categorize events. The metaphysical supposition stresses the nature of science concepts. The last one is the psychological one based on the nature of misconceptions. Based on this theory, when the learners are faced with evidence during science inquiry, they are likely to infer from their current knowledge structure. Allowing them to make such mistakes as well as making them see the inadequacies of the inferences through science activities will cause them to restructure their decision rules This study adapted the Model of Misconception Intervention as stated by Allen (2010).

Furthermore, efforts have been made in Nigeria to diagnose students' misconceptions in the past. Still, most of the diagnoses are restricted to secondary and higher education. For example, Ahiakwo & Isiguzo (2015) diagnosed students' misconception in chemical kinetics, Fatokun (2016), on the other hand, employed concept mapping to correct students' misconceptions of chemical bonding at the secondary school level, Ezenduka, Okafor, and Akusoba (2014) determined the impact of teacher error on students understanding of respiration. However, very little is done on conceptual change among Nigeria's primary and junior secondary schools.

Pupils make predictions.
↓
Early practical activities are poorly resolved. EROs ensure, with recorded observations tending to confirm predictions; many observations contradict the reality of the phenomenon.
↓
Later practical activities are better resolved. Less EROs, with recorded observations tending to increasingly to be more aligned with the reality of the phenomenon.
↓
Teacher demonstration confirms reality of phenomenon; emotional responses triggered by this revelation and by other phases of the lesson may promote engagement with the science.

Figure 1. Rationale for Misconception Intervention Source: Allen (2010)

Pupils are presented with a poser, e.g., an egg will sink in fresh water and saltwater. They are allowed to predict the result
↓
Students are allowed to carry out activities related to the poser. Giving them an egg, salty water and freshwater. During the activity, the teacher engages the learner in verbal conversation, asking them the difference between their response to the poser and current observation
↓
The students are allowed to identify the fault in the decision rules used while responding to the poser, and the decision rules they assume can provide an explanation for the experimental findings
↓
The teacher provides an explanation for the observed dissonance and the right decision rule to apply

Figure 2. Adapted framework for misconception Intervention

Internationally, studies on students' misconceptions in elementary and junior secondary science are numerous. Studies like Wandersee et al. (1994) on electricity, Ferstl and Schneider (2007) Archimedes principle; Hardy, Jonen, Moller, and Stern (2006) floating; Libarkin, Crockett, and Sadler (2003); Roach (2001). In elementary science, students' misconceptions of the concept of floatation and sinking objects appear to have gained several researchers' attention more than any other concept. Studies of Thompson and Logue (2006) and Unal (2008) has separately diagnosed and facilitated conceptual change in floatation through a hands-on activity. Several scholars have attributed the misconceptions of primary students in floatation to their inability to integrate two (weight and volume) variables (Kohn, 1993). Kohn (1993) further established that students in primary have misconceptions because they cannot understand that weight and volume are separate concepts. However, they often fail to integrate them when it comes to a decision making on the concepts of floatation (Kohn, 1993). Also, Pine, Messer and St John (2001) surveyed primary science teachers rating of difficult concepts in primary science in England. The result showed that pupils' find it most challenging to learn that heavy and light objects of identical shape fall at the same speed because they believe that a larger object is heavier and a small object is lighter. Pupils' difficulty follows this to learn that large and small objects weigh the same because they believe that larger is heavier and smaller is lighter.

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Furthermore, Potvin, Sauriol, and Riopel (2015) facilitated conceptual change in students' conception of weight, density, and floatation using the prevalence model; Allen (2010) determined the effect of misconception intervention on learner conceptual change in the same concept. The attention this concept has gained among other science concepts internationally indicates that if the misconceptions of students in this concept are not properly attended, there could be grievous implications to the teaching and learning of science both at the primary and higher levels of science education. However, this study does not believe that students' misconception in the concept of weight, density and floatation is solely responsible for students' poor performance in basic science. Nevertheless, solving the problem of misconceptions in the identified concepts will go a long way in reducing the failure in basic science. In addition, when pupils have the correct conception of these concepts, they will be equipped with adequate decision-making tools because understanding them is required for day-to-day activities. More importantly, these concepts are foundational for learners who will study science at the senior secondary school level. Hence, resolving students' misconceptions as mentioned above will make them learn the concepts at the senior secondary school level with no difficulty.

This study, therefore, determined the effect of misconception intervention in the form of hands-on activity on students learning outcomes in the three major concepts: weight, density, and floatation; learning outcome in this study is limited to conceptual change. This present study also considered the moderating effect of gender and school type on students' learning outcomes. The number of studies that determined the influence of school type and gender on primary pupils' conceptual change in science is rare. These two variables were considered in this study because it has been established that apart from teaching strategy, students and school variable moderates the effect of teaching strategy on students' learning outcomes (Schneider & Preckel, 2017).

The type of school in terms of ownership may inform the classroom practice of the primary science teachers, activities students are exposed to, and the quality of their learning in basic science. This may, in turn, influence the misconceptions of learners. In addition to this, several studies have determined the moderating effect of these two constructs on primary pupils' achievement in science (Sotayo et al., 2016; Oludipe, 2012). Specifically, Dalaklioglu, Demirci and Sekercioglu (2015) found no significant difference in eleventh-grade students' conception of momentum and energy according to their gender. On the other hand, students' misconceptions girls exhibited a given type of misconception more than boys in the concept of solution after a frequency count was done on the qualitative result of total misconceptions found in the students' script (Awan, Khan, & Aslam, 2009). Hence, the moderating effect of gender and school type was determined.

The following hypotheses were tested in this study.

Hypotheses

Ho1 The treatment effect on the conceptual change of students in selected concepts in basic science is not significant.

Ho2 The gender effect on the conceptual change of students in selected concepts in basic science is not significant.

Ho3 The school type effect on the conceptual change of students in selected concepts in basic science is not significant.

Ho4 The treatment effect on the conceptual change of students in selected concepts in basic science does not significantly interact with gender.

Ho5 The treatment effect on the conceptual change of students in selected concepts in basic science does not significantly interact with school type.

Ho6 The gender effect on the conceptual change of students in selected concepts in basic science does not significantly interact with school type.

Ho7 The interaction of treatment, gender and school type on students' conceptual change in selected concepts in basic science is of no significance.

METHOD

This study adopted the pretest-posttest quasi-experimental research design. The population for the study is Basic Nine students in urban parts of Odeda local government area of Ogun state who had already learnt the concepts of density and flotation in Basic Science in School. Another characteristic of this population is that the students are taught using the Ogun state basic science scheme for basic science by a qualified basic science teacher. According to the national policy of education, a basic science teacher is qualified if he has a minimum of Nigerian Certificate of Education (NCE) in Integrated Science. In addition, the same teacher must be certified by the Teacher's Registration Council of Nigeria. Basic nine pupils selected from four co-educational junior secondary schools (two privately owned and two publicly owned) formed the study sample. A school was randomly assigned to the treatment and control groups in each school type. A total of hundred students completed the study, which lasted seven weeks.

Table 1. Research timeline

Week	Activity
Week one	Administration of pretest
Week two to six	Exposing students to the appropriate treatment
Week seven	Administration of posttest

Instrument

The instrument used for data collection is the Basic Science Two-Tier Multiple-Choice Test (**BSTTMCT**) BSTTMCT is four items with two-tier responses. The first tier is the typical response to the multiple choices item. The second tier was for pupils to indicate why they chose the option chosen in the first tier. The instrument was administered to 20 students who were not part of the study. The reliability coefficient BSTTMCT is .86 using Kuder Richardson Formulae 20. The stimulus instrument used for this study is the Misconception Intervention Guide (MIG), a practical guide indicating the experiments and the teacher activity, student activity, materials, and procedure. The details of the MIG is reported in the treatment procedure

Treatment Procedure

Step I: The students are presented with the objective of the lesson

Step II: Students are presented with the definition and explanation of floatation and density concepts, to mention a few.

Step III: Students are requested to document what will happen given a particular situation. For example, putting raw eggs in salty water and ordinary water.

Step IV: Students are presented with activities at the same time, for example

Aim: An experiment to show that density determines floatation and sinking.
Materials: Table salt, two containers like a beaker, tablespoon tap water, two raw eggs, and Graduated cylinder.

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Procedure: Labelled the two containers A and B where container A contains tap water and container B contains tap water plus water. Make sure the two containers contain the same volume of water of about 100ml each. N.B, 1 Cl = 10 ml, ml = cm^3.

1. Add about six (6) tablespoons of salt in container B that contains salt and stir thoroughly with a tablespoon until the salt dissolves completely in the water.
2. Then place one egg in each container and observe which one floats in the container and which one sinks.

Step IV: The teacher asks the students to report their observations and state the reasons why it is so

Step V : The teacher corrects the wrong answers and explains elaborately

Data Analysis

The data collected was analysed using Analysis of Covariance (ANCOVA). The pre-conceptual changes score was used as covariate named pretest and the initial disparity was partial out and statistical effect of the misconception intervention along with main effect of the moderating variable were also determined. Also, the interaction effects of treatment (misconception intervention) and the moderating variable were also determined by the ANCOVA. Where there are main effects, estimated marginal means was used to determine where the main effect lies. For the interaction effects, line graphs and estimated marginal means were used to determine the direction of interaction. The significance level was taken as .05 in the study.

FINDINGS

The following is the first hypotheses question:

Ho1: The treatment effect on the conceptual change of students in selected concepts in basic science is not significant.

As is seen in Table 2 reveals students conceptual change in the selected concepts in basic science responded significantly to the treatment ($F_{(8, 99)}$=26,11; p<.05; η^2=.223) with an effect size 22.3%. Hence, it is inferred that misconception intervention significantly reduced students' misconceptions in the selected concepts in basic science because they scored higher in the post-test.

Table 2. Analysis of covariance result using pre-conceptual change score

	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	179.119[a]	8	22.390	6.308	.000	.357
Intercept	212.609	1	212.609	59.901	.000	.397
Pretest	16.825	1	16.825	4.740	.032	.050
Treatment	**92.686**	**1**	**92.686**	**26.113**	**.000**	**.223**
Schooltype	.171	1	.171	.048	.827	.001
Gender	6.009	1	6.009	1.693	.197	.018
Treatment * Schooltype	.926	1	.926	.261	.611	.003
Treatment * Gender	4.895	1	4.895	1.379	.243	.015
Schooltype * Gender	20.890	1	20.890	5.885	.017	.061
Treatment * Schooltype * Gender	15.972	1	15.972	4.500	.037	.047
Error	322.991	91	3.549			
Total	2835.000	100				
Corrected Total	502.110	99				

a. R Squared = .357 (Adjusted R Squared = .300)

Table 3 below shows that students exposed to misconception intervention were better in terms of their mean score 5.9 than those in the control group 3.9. This also means that the misconception intervention is accountable for the 22.3% of the total variance of students' conceptual change in the selected concept in basic science and technology.

Table 3. Estimated marginal mean of treatment effect

1. treatment Dependent Variable: postest

Treatment	Mean	Std. Error	95% Confidence Interval	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Intervention	5.901(a)	.273	5.358	6.444
Control	3.904(a)	.278	3.351	4.457

a Covariates appearing in the model are evaluated at the following values: pretest = 2.4900

This means that students exposed to the intervention could use correct decision rule(s) for their decision making in the post-test. This means that their reasoning and conception while solving problems in the post test showed that there is a change in their conception of density and floatation. Unlike the control group who were unable to solve more problems

The following is the second hypotheses question:

Ho2: The treatment effect on the conceptual change of students in selected concept in basic science is not significant.

Table 2 above reveals that gender affects students' conceptual change in the selected concept in basic science is not significant ($F_{(8, 99)}$=1.63; p>.05). Therefore, it is deduced that gender did not significantly affect students' conceptual change in selected concepts in basic science and their misconceptions.

The following is the third hypotheses question:

Ho3: The effect of school type on students' conceptual change in the selected concept in basic science is not significant.

Table 2 above reveals that the effect of school on students' conceptual change in the selected concept in basic science is not significant ($F_{(8, 99)}$=.048; p>.05). This means that the conceptual change of basic nine students in the density and floatation concept is not affected significantly by the type of school they attended.

The following is the fourth hypotheses question:

Ho4: The effect of treatment on students' conceptual change in the selected concept in basic science does not interact with gender significantly.

As shown in Table 2, the treatment and the gender interaction effect is insignificant on the conceptual change of basic nine students ($F_{(1,91)}$=1.379; p>.05). Therefore, the effect of treatment on students' conceptual change is insensitive to their gender.

The following is the fifth hypotheses question:

Ho5: The effect of the interaction of treatment and school type on students' conceptual change in basic science is not significant.

It is deduced from Table 2 that the effect of treatment on the conceptual change of students in basic science does not interact with the type of school they attend significantly, and hypothesis Ho5 is rejected. Overall the effect of treatment on conceptual change is not sensitive to school type.

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The following is the sixth hypotheses question:

Ho6: The effect of gender on students' conceptual change in the selected concept in basic science basic science does not interact with school type significantly

Table 2.0 reveals that the gender and school type has a significant interaction effect on students conceptual change in basic science ($F_{(1,91)}$=5.88;p<.05; η2=.061) with an effect size of 6.1%. This implies that students' gender and the type of school they attend taken together have a significant effect on conceptual change.

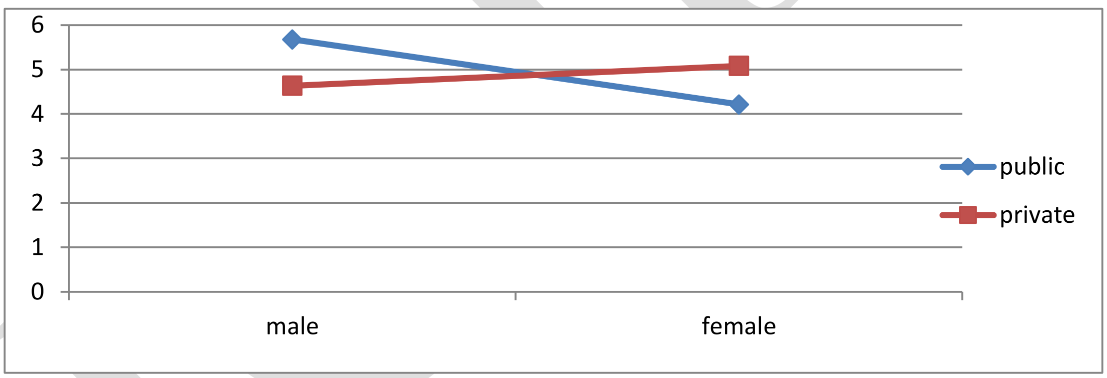
Table 4. Estimated marginal mean of the interaction effect of gender and school type according to the post-test conceptual change in selected concept in basic science.

Dependent Variable: posttest

Gender	Schooltype	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Male	Public	5.677[a]	.451	4.781	6.574
	Private	4.635[a]	.426	3.789	5.482
Female	Public	4.215[a]	.333	3.553	4.876
	Private	5.083[a]	.345	4.397	5.768

Table 4 reveals that the significant interaction effect of gender favoured males in public school conceptual change because they have the highest post-test mean score. However, the females in private schools are next to the males in public schools in terms of the mean. This interaction is disordinal. Figure 3 below presents the interaction of gender and school type graph.

Figure 3. Graph of Interaction of gender and school type on conceptual change.



This implies that male students in public school used the correct decision rule to solve problems related to weight, floatation and density during the post-test.

The following is the seventh hypotheses question:

Ho7: The effect of treatment on students' learning outcomes in selected concepts in basic science does not significantly interact with gender and school type.

Table 2 above reveals that three-way treatment, gender, and type of school which students attend affect students' conceptual change in the selected concepts in basic science significantly ($F_{(8,99)}$=4.5; p<.05; η^2=.047) with an effect size 4.71%. Therefore, in the upper basic nine basic science, the method of teaching, gender and type of school determines the conceptual change in the selected concepts.

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Table 5. Estimated marginal means of interaction treatment, gender and school-type

Treatment	Gender	Schooltype	Mean Lower Bound	Std. Error Upper Bound	95% Confidence Interval Lower Bound	Upper Bound
intervention	Male	Public	6.130(a)	.628	4.882	7.377
		Private	5.721(a)	.570	4.590	6.853
	Female	Public	5.959(a)	.471	5.023	6.895
		Private	5.795(a)	.504	4.793	6.797
Control	Male	Public	5.225(a)	.647	3.940	6.509
		Private	3.549(a)	.630	2.297	4.801
	Female	Public	2.470(a)	.471	1.534	3.406
		Private	4.371(a)	.471	3.435	5.306

a Covariates appearing in the model are evaluated at the following values: pretest = 2.4900

Table 5 above shows the estimated marginal of the three-way interactions treatment, gender and school type and estimated marginal means. The table above shows that male students exposed to misconception intervention in public school ($\bar{x}$=6.13) and private schools ($\bar{x}$=5.72) have a higher mean compared to their counterparts in the control groups public school ($\bar{x}$=5.22) and private school ($\bar{x}$=3.55). Also, females exposed to misconception intervention in public school ($\bar{x}$=5.96) and private schools ($\bar{x}$=5.72) have a higher post-test mean score than their counterparts in the control group public school ($\bar{x}$=2.47) and private schools ($\bar{x}$=4.37). Overall the three-way interaction was found to favour students who are male in public schools profoundly because based on their mean score; students in this group were able to answer 3 (assuming they obtained the correct answer for 3 items; the question and the tier) or 5 (assuming 5 questions and their tier).

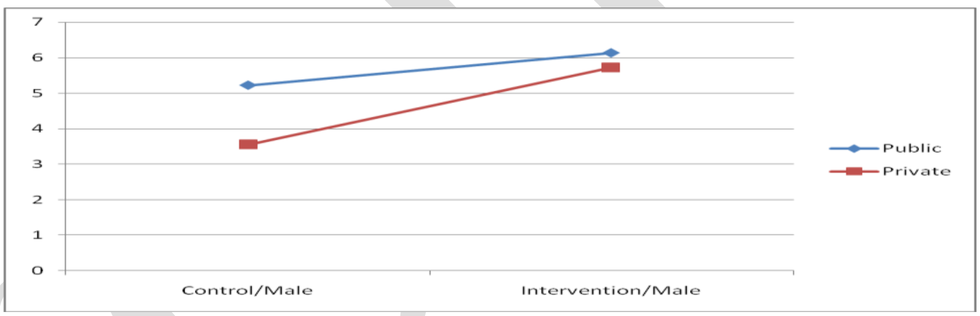

Figure 4. Line graph of interaction of treatment, school type and gender for male

The graph is ordinal and indicates that the male students exposed to the misconception intervention and control in public school are better than males in the private schools in the two treatment groups.

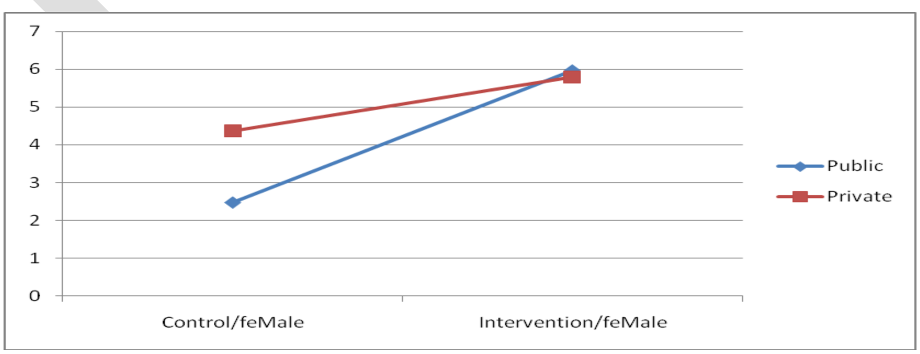

Figure 5. Graph of interaction treatment, gender, and school type on conceptual change for female

DISCUSSION, CONCLUSION, and RECOMMENDATIONS

This study revealed that the misconception intervention in the form of activity the students carried out significantly facilitated their conceptual change with respect to their gender and school type. Although the result indicated that the three-way interaction of treatment, school type and gender was most profound among males in public, the post-test mean scores of females (public and private) and males (private) exposed to misconception intervention were better. The findings may be attributed to the fact that male students in public schools were very excited to participate in the activity and probably dominated the activity. Overall, conceptual change is better facilitated when students are exposed to activities that challenge their misconception intervention in this study than the didactic approach.

Although the three-way interaction effect subsumes the main effect of treatment, it is important to underscore the treatment effectively facilitated the conceptual change of the learners compared to the control group given the large effect size. This is in line with the findings of Ajlouni & Jaradat (2020) which showed that Jordanian primary school pupils who were exposed to pedagogical hypermedia acquired scientific concepts more than those in the control. The study found out that the treatment accounted for 70% of total variance of the conceptual change score. The effect of the treatment may be traced to the claim of (Duckworth, 2011) that students need to be given many opportunities to investigate both volumes independent of mass and mass-independent of volume to gain a thorough understanding of floatation and density. Misconception intervention in this study offered students such an opportunity. The findings of this study is also in line with that of Unal (2008), which shows that students exposed to hands-on activity have a significant positive effect on floatation concepts and rules. Also, the finding of this present study aligns with that of Woldeamanuel et al (2020) that Ethiopian grade eight students taught using concept mapping instructional method exhibited better conceptual understanding of the concept of photosynthesis than those treated with lecture method. It can be deduced that conceptual change will most likely take place in classroom which science concepts are taught using any method that will ensure that students are confronted with their own errors. And lecture method hardly does this.

Unlike most studies on conceptual change, that do not give attention possible moderating effect of variable different from teaching methodology, this study indicates that male and female students exposed to the misconception intervention in the public had a better conceptual change score than their counter in private schools. This finding may be attributed to many factors: students in the public schools were observed to show interest in the activity more than their counterparts in private schools. The finding of this study established that misconception intervention can be used to bridge the little gap that existed in terms of achievement in science between public and private school students.

Conclusion

The findings of this study point at many things among them is that misconception interventions in the form of hands-on activity is an effective instructional approach that can facilitate conceptual change among both the male and female public primary school students and also bridge the prior achievement gap which existed between the private and public-school students.

Recommendations

Based on this finding, the following recommendations were made

1. To improve the performance of male and female students, especially in public primary schools, science teachers should adopt the misconceptions intervention instructional approach. The conceptual change in basic science depends mainly on the activities which expose the fault lines in the misconceptions of basic nine students.
2. There is a need to develop similar misconception intervention activities for other basic science concepts using materials that the basic nine students interact with daily. In addition, the materials

used for the misconception activities are readily available in the home, kitchen and environment of learners. This provides the students' opportunities to repeat the misconception intervention activities.

3. Teachers should diagnose the misconceptions the students may have in the concepts they intend to teach in basic science.
4. Primary science teachers should also replace the common mode of assessment such as multiple-choice, essay and matching items when they want to measure the conception of learners with alternative assessment tools such as two-tier multiple-choice and interviews. This will provide information on students' misconceptions
5. Researchers should carryout research that will develop misconception interventions for other concepts in basic science. This study could be replicated at the senior secondary physics in correcting misconceptions of the concept of floatation.

The findings of this study are not without limitations. The activities used as misconception intervention in this study are activities that appeal to the pupil's cultural outlook. Replicating the study in environment with different cultural outlook may not lead to similar findings.

Ethics and Conflict of Interest

The authors acted in accordance with the ethical rules in the research and there is no conflict of interest between the authors.

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