

## Influence of Outdoor Laboratory Instruction on Secondary School Students' Interest and Achievement in Reflection and Refraction Concepts in Jos North, Nigeria

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**Article DOI:**

10.48028/iiprds/esjprcd.v11.i1.09

**Keywords:**

Outdoor laboratory  
instruction,  
Reflection of light,  
Refraction of light,  
Students' interest,  
Students'  
achievement,  
Students' gender

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This study investigated the influence of outdoor laboratory instruction on secondary school students' interest and achievement in reflection and refraction concepts in Jos North, Nigeria. The study adopted the non-equivalent control group pre-test, post-test quasi-experimental research design because intact classes were employed for the study. A total sample of 90 senior secondary two students offering Physics from two co-educational senior secondary schools, selected from the population, using purposive sampling technique was used for the study. One class from one of the two sampled schools was randomly assigned the experimental group while the other class was assigned the control group. Physics Students' Interest Questionnaire (PSIQ) and Reflection and Refraction Achievement Test (R-RAT), which were validated by three experts from the University of Jos, were the instruments used to gather data. The reliability coefficients of the PSIQ and the R-RAT, which were determined using Cronbach Alpha method and Kuder-Richardson formula 21 (K-R21) respectively, were obtained as 0.78 and 0.91. Four research questions were raised and answered using mean and standard deviation and four hypotheses were formulated and tested at 0.05 significant level using t-test of independent samples and ANCOVA. The findings of the study revealed, inter alia, that students who were taught Physics using outdoor laboratory instruction exhibited higher interest in Physics and achieved higher in the subject than their counterparts who were exposed to expository instruction. Based on the findings, it was recommended amongst others, that Physics teachers should be encouraged to adopt the use of outdoor laboratory instruction in teaching Physics.

### **Background to the Study**

The teaching and learning of science subjects are the key aspects in the science education sector. These aspects are not up to the target considering the global increase in demand for scientific and technological knowledge. This makes it necessary for science educators to find promising instructional techniques to improve the teaching and learning to enable learners to cope with the needs of the time and prepare them to compete effectively in the contemporary and dynamic world (Baba and Dawal, 2020). Scientific principles are required by all nations to assist in developing technological innovations in this modern competitive world. For any nation to develop technologically and socio-economically, it requires a strong scientific background. This background may be achieved through the effective teaching and learning of science subjects in secondary schools. One of the national education goals of Nigeria (Federal Government of Nigeria [FRN] (2014) emphasized that education should provide learners with the appropriate skills and also develop mental, physical and social abilities and competencies that will equip them to contribute to the technological and socio-economic advancement of Nigeria.

The core science subjects in secondary schools in Nigeria that science students offer as part of their school subjects, and which constitute the foundation of their studies in higher institutions of learning, are Biology, Chemistry and Physics. Physics is the study of matter and energy and the interactions that exist between them. Ndupu and Okeke (2007) opined that Physics is a hands-on, activity-based subject in that every discovery of science has been possible due to experimental investigations in Physics. The study of Physics offers students an opportunity to think critically, reason analytically and acquire the spirit of inquiry as opined by Achor and Gbadamosi (2020). When students at the secondary school level learn Physics and are able to think critically, reason analytically and acquire the spirit of inquiry, they become instrumental to the development of their nation. Josiah (2013) posited that learning Physics concepts is incomplete without students acquiring practical Physics knowledge. Lending credence, Mbia and Nsungu (2019) held the view that the knowledge of Physics forms the foundation for technological advancement of any nation. Physics is the foundation upon which the scientific and technological advancement of a nation rests. Abamba (2021) opined that Physics is the link between all the science subjects at the secondary school level of education and the technological courses at the tertiary level. Therefore, the objective of providing basic Physics literacy to secondary school students for functional living in the society (Nigerian Educational Research and Development Council [NERDC] (2008), must not be downplayed.

In spite of the enormous role that Physics plays in national development such as in modern construction, automobiles and in meeting energy requirements, Omega (2017), Achor and Gbadamosi (2020), Abamba (2021), Agube, Ntibi, and Neji (2021) reported the existence of ineffective teaching and learning of Physics as majority of the teachers employ ineffective and passive methods of instruction that culminate to students having low or no interest and poor achievement. In the context of this study, students' performance is the same as their achievement. The methods of instruction, which are expository in nature, do not encourage students to actively participate and apply their creative minds when learning. The students

thereby find it difficult to understand Physics and consequently loose interest. These methods of instruction contradict the objectives of learner-centred methods of instruction, which the contemporary world of education has long embraced and which Enekwechi (2016) reported allow students to actively participate in the teaching and learning process. These learner-centred methods of instruction are likely to culminate into meaningful learning instead of rote learning and increase students' interest. Outdoor laboratory instruction is one of such learner-centred methods of instruction.

According to Oyeniyi (2020), outdoor laboratory instruction is a method of instruction that is activity-based, relating to students' natural environment, reduces the abstract nature of science, enables students to learn with team spirit and respect for the views of others. The abstract concepts in Physics become real to students when such concepts have been directly experienced during outdoor laboratory instruction. The students retrieve, and have first-hand, information about such abstract concepts by carrying out observations in natural environments outside the classroom or indoor laboratory. In the outdoor laboratory instruction, learning is achieved outside the walls of the classroom or indoor laboratory. Students engage in specific purpose learning which includes concepts being learned and better understanding of the learning environment. The method may also entail gathering data from outside the classroom and school laboratory which can be analyzed at the end of the exercise.

Oyovwi (2020), wrote that outdoor laboratory instruction uses outdoor science activities which reduces concept abstraction, enhances lesson clarity, captivates students' interest, encourages students' active participation in the teaching-learning process and improves students' ability to remember learnt concepts by providing the students with real-life experiences that translate into achievement. Djajadi and Rauf (2020), opined that the outdoor laboratory instruction enhances students' interest and achievement in science subjects because the method of instruction boosts students' activeness, confidence and seriousness to learn concepts. Supplementing on outdoor laboratory instruction, Ogechukwu (2020) concluded that students' interest towards Physics predicts about 57% of their achievement in the subject. Alfiani (2020) found out that outdoor laboratory instruction has a significant effect on students' interest in Physics. Arianti and Aminatun (2019) had also earlier noted that outdoor laboratory instruction enhances students' interest and improves their learning outcomes (achievement inclusive) because it supplies them with authentic and interactive experiences and experiential learning opportunities.

In their study, Arianti and Aminatun (2019), found out that outdoor laboratory instruction increases students' cognitive learning outcomes because students who are taught using the outdoor laboratory instruction understand concepts which result to improved achievement. Although Saidu and Suleiman (2014) much earlier found out that there was no significant difference in the achievement of high, medium and low ability students in Biology before they were exposed to outdoor laboratory instruction, the duo's study further showed that there was no significant difference in the achievement of students in the three ability groups after exposure to the outdoor laboratory instruction. This shows that the outdoor laboratory

instruction does not only enhance and sustain students' interest, but it also serves as an important source of supplying and updating students' knowledge. Alfiani (2020) found out that the outdoor laboratory instruction has a significant effect on students' achievement in Physics. Oyeniyi's (2020) study revealed that there is a significant difference between the mean achievement scores of students taught using outdoor laboratory instruction and those taught using expository instruction.

Gender is an attribute that differentiates females from males in terms of biological, social or traditional roles. Gender interest and achievement in Physics, and science in general, have over the years become such controversial issues that educational researchers have become so wary about and have no point of convergence. Even though Ojih, Esiokpe and Okafor (2016), found out that both male and female students perceive Physics as interesting, they also found out that there is a significant difference in the mean ratings of male and female students in factors (lack of students' interest in Physics inclusive) responsible for low enrolment of students in Physics in institutions of higher learning in Nigeria. This low enrolment of students in Physics in institutions of higher learning in Nigeria could imply that students' achievement in Physics at the secondary school level of education has not been impressive. Furthermore, Saidu and Suleiman's (2014) and Oyovwi's (2020) studies revealed that the outdoor laboratory instruction does not have significant difference in the achievement of male and female students. In another study on enhancing students' achievement in the concepts of work, energy and power, Josiah and Emmanuel (2022) found out that there is no significant difference between male and female students' achievement. Stevenson, Szczytko, Carrier and Peterson's (2021) study revealed that outdoor laboratory instruction increases knowledge and maintains science grades for female students.

To the best of the knowledge of the researchers, little or no studies on the influence of outdoor laboratory instruction on secondary school students' interest and achievement in reflection and refraction concepts have been undertaken in Jos North, Nigeria. Jos North is a local government area in Plateau State, Nigeria and the capital city of the state. In the context of this study, it has been delineated as Jos North. This study was, therefore, carried out to ascertain if the use of the outdoor laboratory instruction (OLI) in secondary schools in Jos North, Nigeria would achieve the following specific objectives: ascertain the difference between the mean interest scores of senior secondary school students who are exposed to OLI and those exposed to expository instruction (EI); determine the extent to which the mean interest score of senior secondary school male students who are exposed to OLI differ from that of their female counterparts; find out the extent to which the mean achievement score of senior secondary school students who are exposed to OLI differ from that of those who are exposed to EI; determine the difference between the mean achievement scores of senior secondary school male and female students who were exposed to OLI; determine whether there exist a significant effect of gender on senior secondary school students' interest in the concepts of reflection and refraction of light when exposed to OLI; and ascertain whether there is a significant interaction effect of treatment and gender on senior secondary school students' achievement in the concepts of reflection and refraction of light in Physics.

### **Statement of the Problem**

Students' low or lack of interest in Physics and their poor and fluctuating achievement in the subject has resulted into a situation where many students have failed to advance in studying Physics or Physics-related courses in institutions of higher learning. If this trend is left unchecked, it will result in low number of science teachers, scientists, engineers, doctors, agriculturalists and the likes in Nigeria. Consequently, Nigeria's aim of advancing in science and technology in this 21st century may likely fail. Studies by Trumper (2006), Oon and Subramaniam (2013), Ojih, Esiekpe and Okafor (2016) reported students' exhibition of neutrality in their overall interest in Physics and their low or no interest in the subject because of difficulty in the nature of Physics and lack of encouragement from parents and peers. Other studies by Josiah (2012), Nyongesa (2014), Njiru and Karuku (2015), Inyang and Josiah (2016), Ojih, Esiekpe and Okafor (2016), Josiah and Gana (2019), Lasisi and Samaila (2020), Josiah and Pwol (2020) further reported that the methods of instruction used in teaching, poor teachers' knowledge of content and students' poor background in Mathematics also lead to students' poor achievement in Physics. Despite the global efforts that have been made by researchers to remedy the situation, there seems to be no empirical evidence that students' interest in Physics in Jos North, Nigeria has improved. Could the adoption of the outdoor laboratory instruction as a strategy in teaching Physics improve students' interest which could consequently lead to high achievement in the subject?

### **Research Questions**

The following research questions guided the study:

1. What is the difference between the mean interest scores of senior secondary two (SS II) students who were exposed to outdoor laboratory instruction (OLI) and those exposed to expository instruction (EI)?
2. To what extent does the mean interest score of SS II male students who were exposed to OLI differ from that of their female counterparts?
3. To what extent does the mean achievement score of SS II students who were exposed to OLI differ from that of those who were exposed to EI?
4. What is the difference between the mean achievement scores of SS II male and female students who were exposed to OLI?

### **Hypotheses**

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the pre-test mean interest scores of SS II students who were exposed to OLI and those who were exposed to EI.
2. There is no significant effect of gender on SS II students' interest in the concepts of reflection and refraction of light when exposed to outdoor laboratory instruction.
3. There is no significant difference in the pre-test mean achievement scores of SS II students who were exposed to OLI and those who were exposed to EI.
4. There is no significant interaction effect of treatment and gender on SS II students' achievement in the concepts of reflection and refraction of light.

## **Methodology**

The study adopted the non-equivalent control group pre-test, post-test quasi-experimental research design. The population of the study comprised 900 senior secondary two (SS II) students offering Physics in the 30 government-approved co-educational secondary schools in Jos North local government area, Nigeria. The sample for the study consisted of 90 SS II students (42 males and 48 females) offering Physics obtained from two intact classes, one each from two co-educational secondary schools purposively selected from the population. The following was used as the criteria for the selection of the sample schools: Qualified Physics teacher who had been teaching Physics in the school not less than five years, and the school had been using the senior secondary school Physics curriculum by NERDC. One of the two intact classes was randomly assigned the experimental group while the other was assigned the control group. Senior secondary two students were used for this study because SS III students were preparing for their West African Examinations Council (WAEC) and National Examinations Council (NECO) Senior School Certificate Examination (SSCE) and SSI students are newly exposed to the concepts of senior secondary school Physics.

Two instruments were used for data collection: Physics Students' Interest Questionnaire (PSIQ) and Reflection and Refraction Achievement Test (R-RAT) developed by the researchers. The PSIQ is a 30-item likert scale instrument with the rating Strongly Agree (SA) = 5 points, Agree (A) = 4 points, Undecided (U) = 3 points, Disagree (D) = 2 points and Strongly Disagree (SD) = 1 point for positively-stated items. The rating was reversed for negative statements. The PSIQ was developed to elicit information on students' interest in Physics. The R-RAT is a 30-item multiple-choice instrument, with each item having four options (A, B, C, and D). The questions in R-RAT, which were drawn from past WAEC and NECO SSCE Physics questions on the concepts of reflection and refraction of light, have only one correct option for each item. Two marks were allocated to each correct option and zero mark to each wrong answer. Each of the instruments was validated by three experts from the University of Jos, Nigeria. The reliability of the PSIQ was determined using Cronbach Alpha method and its reliability coefficient was obtained as 0.78. Kuder-Richardson formula 21 (K-R21) was used to compute the reliability coefficient of R-RAT as 0.91. Prior to treatment, the PSIQ was first administered as pre-test in order to determine the students' initial interest in Physics. Thereafter, the R-RAT was administered to determine the students' initial achievement.

After the treatment using the outdoor laboratory instruction to teach concepts of reflection and refraction of light for the period of four weeks to the experimental group, the items in the PSIQ and R-RAT were reshuffled and administered to the students as post-tests. The post-tests were conducted so as to find out the influence of the treatment on students' interest and achievement in Physics. Data for the study were analyzed using statistical tools; the mean and standard deviation were used to answer the six research questions that were raised for the study. The t-test of independent samples was employed to test hypotheses one and three at 0.05 level of significance, while Analysis of Covariance (ANCOVA) was used to test hypotheses two and four also at 0.05 level of significance.

## Results

### Research Question One

What is the difference between the mean interest scores of senior secondary two (SS II) students who were exposed to outdoor laboratory instruction (OLI) and those exposed to expository instruction (EI)?

**Table 1:** Pre-test and Post-test Mean Interest Scores and Standard Deviations of SS II Students Exposed to OLI and EI

Group	N	Pre-interest		Post-interest		Mean gain
		Mean	S. D	Mean	S. D	
Experimental	40	2.75	0.19	4.05	0.19	1.30
Control	50	2.66	0.12	3.07	0.21	0.41
<b>Gain difference</b>						0.89

Source: SPSS Output

From table 1, the gain in the mean interest scores for the students who were taught the concepts of reflection and refraction of light using OLI (experimental group) was higher than that of the students who were taught using EI; the mean gain difference being 0.89 in favour of the students who were taught using OLI. This difference in the mean gain interest scores, which favoured the students who were taught using OLI, could be as a result of their exposure to treatment.

### Research Question Two

To what extent does the mean interest score of SS II male students who were exposed to OLI differ from that of their female counterparts?

**Table 2:** Pre-test and Post-test Mean Interest Scores and Standard Deviations of SS II Students Male and Female Exposed to OLI

Gender	N	Pre-interest		Post-interest		Mean gain
		Mean	S. D	Mean	S. D	
Male	20	2.82	0.18	4.02	0.17	1.20
Female	20	2.89	0.19	4.07	0.20	1.18
<b>Gain difference</b>						0.02

Source: SPSS Output

Table 2 shows that the gain in the mean interest scores for the female students who were exposed to learning the concepts of reflection and refraction of light using the OLI was slightly lower than that of their male counterparts; the mean gain difference being 0.02 in favour of the male students. This difference between the gains in the mean interest scores of both gender was not much.

### Research Question Three

To what extent does the mean achievement score of SS II students who were exposed to OLI differ from that of those who were exposed to EI?

**Table 3:** Pre-test and Post-test Mean Achievement Scores and Standard Deviations of SS II Students Exposed to OLI and EI

Group	N	Pre-test		Post-test		Mean gain
		Mean	S. D	Mean	S. D	
Experimental	40	11.50	3.61	20.20	4.75	8.70
Control	50	11.72	2.89	13.36	2.88	1.64
<b>Gain difference</b>						7.06

Source: SPSS Output

From table 3, it is observed that the gain in the mean achievement scores for the students who were taught the concepts of reflection and refraction of light using OLI was much higher than that for the students who were taught same Physics concepts using EI; the mean gain difference of 7.06 favoured the students who were taught using OLI. This difference between the mean gains could be attributed to the students' exposure to treatment using OLI.

### Research Question Four

What is the difference between the mean achievement scores of SS II male and female students who were exposed to OLI?

**Table 4:** Pre-test and Post-test Mean Achievement Scores and Standard Deviations of SS II Students Male and Female Exposed to OLI and EI

Gender	N	Pre-test		Post-test		Mean gain
		Mean	S. D	Mean	S. D	
Male	20	11.90	3.91	20.25	5.23	8.35
Female	20	12.21	3.20	20.15	4.34	7.21
<b>Gain difference</b>						1.14

Source: SPSS Output

Table 4 indicates that the mean achievement scores gain for the male students who were taught the concepts of reflection and refraction of light using OLI was slightly higher than that of their female counterparts; the mean gain difference of 1.14 being in favour of the male students. This difference between the gains in the mean achievement scores of each gender was not much.



### Hypothesis One

There is no significant difference between the pre-test mean interest scores of SS II students who were exposed to OLI and those who were exposed to EI.

**Table 5:** t-test of Independent Samples Analysis of Pre-test Mean Interest Scores of Students taught using OLI and EI

Group	N	Mean	Std. deviation	t-value	Df	P-value	Decision
Experimental	40	2.75	0.19	2.710	88	0.212	Retained
Control	50	2.66	0.12				

$P > 0.05$

Source: SPSS Output

Table 5 shows that when the pre-test mean interest scores of the two groups were compared statistically using independent samples t-test,  $df=88$ ,  $t=2.710$ , and  $P= 0.212$ . The  $P$ -value 0.212 is greater than the alpha value of 0.05 ( $P > 0.05$ ). Therefore, the null hypothesis was retained; there was no significant difference between pre-test mean interest scores of SS II students who were taught the concepts of reflection and refraction of light using OLI and those who were taught using EI. This implies that the two groups were at the same interest level before the commencement of treatment and were therefore suitable for the study.

### Hypothesis Two

There is no significant effect of gender on SS II students' interest in the concepts of reflection and refraction of light when exposed to outdoor laboratory instruction.

**Table 6:** ANCOVA Results of Effect of Gender on Students' Interest in Concepts of Reflection and Refraction of Light when Exposed to OLI

Dependent Variable: Post -Interest

Source	Type III Sum of Squares	df	Mean Square	F	P	Decision
Corrected Model	.039 <sup>a</sup>	2	.020	.542	.586	
Intercept	3.552	1	3.552	98.578	.000	
Pre-Interest	.020	1	.020	.562	.458	
Gender	.006	1	.006	.178	.676	Retained
Error	1.333	37	.036			
Total	655.853	40				
Corrected Total	1.372	39				

a. R Squared = .028 (Adjusted R Squared = -.024)

Source: SPSS Output

The ANCOVA result from Table 6 reveals that F-value (1,39) for the gender (male and female students) was found to be 0.178 with significant difference of P at 0.676,  $P(0.676 > 0.05)$ ; the P-value 0.676 was greater than the alpha value of 0.05. The hypothesis was, therefore, not rejected; there was no significant effect of gender on SS II students' interest in the concepts of reflection and refraction of light when exposed to the outdoor laboratory instruction. This means that the outdoor laboratory instruction is a gender-friendly method of instruction that enhances both male and female students' interest in concepts of reflection and refraction of light.

### Hypothesis Three

There is no significant difference in the pre-test mean achievement scores of SS II students who were exposed to OLI and those who were exposed to EI.

**Table 7:** t-test of Independent Samples Analysis of Pre-test Mean Achievement Scores of Students taught using OLI and EI

Group	N	Mean	Std. deviation	t-value	Df	P-value	Decision
Experimental	40	11.50	3.61	-0.348	88	0.729	Retained
Control	50	11.72	2.89				

$P > 0.05$

Source: SPSS Output

Table 7 reveals that when the pre-test mean achievement scores of the two groups were statistically compared using independent samples t-test,  $df = 88$ ,  $t = -0.348$  and  $P = 0.729$ . The P-value 0.729 was greater than the alpha value of 0.05 ( $P > 0.05$ ). Therefore, the hypothesis was retained; there was no significant difference in the pre-test mean achievement scores of SS II students who were exposed to OLI and those who were exposed to EI. The implication is that the two groups were at the same cognitive level prior to treatment and were therefore suitable for the study.

### Hypothesis Four

There is no significant interaction effect of treatment and gender on SS II students' achievement in the concepts of reflection and refraction of light.

**Table 8:** ANCOVA Results of Interaction Effect of Treatment and Gender on Students' Achievement in the Concepts of Reflection and Refraction of Light

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	P	Decision
Corrected Model	378.617 <sup>a</sup>	2	21.034	.884	.601	
Intercept	10497.797	1	10497.797	441.099	.000	
Gender	11.098	1	11.098	.466	.502	
Pretest	223.794	11	20.345	.855	.593	
Treatment * Gender	133.379	6	22.230	.934	.491	Retained
Error	499.783	21	23.799			
Total	17200.000	40				
Corrected Total	878.400	39				

a. R Squared = .431 (Adjusted R Squared = -.057)

**Source:** SPSS Output

The ANCOVA result from Table 8 revealed that F-value (1,39) for the treatment and gender was found to be 0.934 with significant difference of P at 0.491,  $P(0.491 > 0.05)$ . The P-value 0.491 was greater than the level of significance 0.05. The hypothesis was, therefore, not rejected; There was no significant interaction effect of treatment and gender on SS II students' achievement in the concepts of reflection and refraction of light. For gender alone,  $P(0.502 > 0.05)$  was greater than the alpha value of 0.05. Therefore, the outdoor laboratory instruction is gender-friendly.

**Discussion**

The difference in the mean gain interest scores from Table 1, which favoured the students who were taught the concepts of reflection and refraction of light using outdoor laboratory instruction, could be as a result of their exposure to the method of instruction. This finding is in line with the finding of Arianti and Aminatun (2019) that outdoor laboratory instruction enhances students' interest. In terms of gender, the gain in the mean interest scores for the female students who were exposed to learning the concepts of reflection and refraction of light using the outdoor laboratory instruction was only slightly lower than that of their male counterparts (Table 2). This finding agrees with that of Ojih, Esiokpe and Okafor (2016) that both gender of students perceive Physics as an interesting subject. Moreover, from Table 6 there was no significant effect of gender on students' interest in the concepts of reflection and refraction of light when exposed to the outdoor laboratory instruction. This implies that the outdoor laboratory instruction is not biased toward any students' gender when their interest in concepts of reflection and refraction of light is considered. This finding is in contrast with that of Ojih, Esiokpe and Okafor (2016) that there is a significant difference in the interest of male and female students in Physics.

From Table 3, the gain in the mean achievement scores for the students who were taught the concepts of reflection and refraction of light using the outdoor laboratory instruction was much higher in comparison with that of the students who were taught same Physics concepts using the expository instruction. This difference between the mean gains could be attributed to the students' exposure to concepts of reflection and refraction of light using the outdoor laboratory instruction. This finding conforms with that of Stevenson, Szczytko, Carrier and Peterson's (2021) which revealed that the outdoor laboratory instruction increases students' knowledge. Furthermore, Table 8 revealed that there was no significant interaction effect of the outdoor laboratory instruction and gender on students' achievement in the concepts of reflection and refraction of light. This implies that there may not be need for separation of instructional method when teaching male and female students the concepts of reflection and refraction of light using the outdoor laboratory instruction since it has been found to be gender-friendly. This finding is in line with the findings of Saidu and Suleiman (2014), Oyeniyi (2020) and Oyovwi (2020) that the outdoor laboratory instruction does not have significant difference in the achievement of male and female students.

### **Conclusion**

The use of the outdoor laboratory instruction enhances students' interest and achievement in the concepts of reflection and refraction of light. Moreover, no gender disparity was found to exist in the interest and achievement of male and female students who were taught the Physics concepts using the outdoor laboratory instruction. The outdoor laboratory instruction is therefore projected as very rewarding to students in terms of their interest and achievement, regardless of gender. Therefore, there is no need to use different instructional methods for male and female students when teaching the concepts of reflection and refraction of light in Physics.

### **Recommendations**

Based on the findings of the study, the following recommendations were made:

1. Ministries of Education should be encouraged to organize workshops, conferences and seminars on the need for schools to employ outdoor laboratory instruction in teaching reflection and refraction of light and other Physics concepts so as to enhance students' interest and achievement.
2. Physics teachers should be encouraged to use outdoor laboratory instruction to teach both male and female students since the method is not gender sensitive and it increases their interest and achievement in Physics concepts.

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