The effect of guided discovery on students' Physics achievement

Garuma Abdisa[1], Tesfaye Getinet[2]
[1]*Department of Physics, Mettu University, Ethiopia.*
[2]*College of Education and Behavioral Studies, Addis Ababa University, Ethiopia*.

E-mail: garumaa@yahoo.com

(Received 14 August, 2012, accepted 25 November 2012)

Abstract

The study investigated and contrasted the relative effectiveness of guided discovery, demonstration and traditional lecture method of teaching on students' achievement in rotational motion. Grade 11 students from three selected preparatory schools in Ilu Aba Bora Zone located in southwestern part of Ethiopia took part in the study. The specific research design adopted in the study was pretest-posttest nonrandomized control groups experimental design. A purposive sampling technique was used to select three preparatory schools out of six preparatory schools in the zone. The whole research process took place within the natural classroom setting. The guided discovery, demonstration and the traditional methods were implemented in Mettu, Yayo Aida Thea and Gore Secondary and Preparatory Schools, respectively. The total number of students who took part in the study were 114 comprising of 73 males and 41 females. Researcher developed physics achievement test (RDPAT) with internal consistency of 0.77 using Kuder-Richardson formula 20 for pretest and 0.80 for posttest was used as data collection instrument in the study. The first semester result of the students who took part in the study was also used from the students' rosters to establish the construct validity of the RDPAT test. The statistical tests used in the study were mean and standard deviation, ANCOVA, t-test, ANOVA, Scheffè post hoc test, Cohen's d and η^2 effect sizes. Kolmogorov-Smirnov test was used to test the normality of the posttest scores, which is a key assumption in t-test and ANOVA. Analysis with ANCOVA and Scheffè test showed that the guided discovery method was the most effective teaching method (with an average gain score of 0.43) followed by the demonstration (average gain score 0.34). The traditional method was found to be the least effective (average gain score 0.26).The statistical analysis used students' background as the covariate. The R square value indicates that approximately 57% of the total variance in the achievement of the students in dynamics of rotational motion can be attributed to the specific teaching methods employed. There was no significant difference between the achievement of male and female students who were taught with guided discovery, demonstration and the traditional method. There was a significant difference between the achievements of each pair of high-, medium-, and low-achiever students' scores who were taught with guided discovery and demonstration. This implies that the students' achievement has a strong relationship with their background performance levels (high-, medium- and low-achiever) besides the effect of the instructional methods. It is recommended that physics teachers in the zone should implement guided discovery with sufficient guidance to help students create, integrate, and generalize knowledge through constructivist problem solving by providing them with materials available in physics lab or locally prepared teaching materials.

Keywords: Guided discovery, demonstration, physics achievement, preparatory schools.

Resumen

El estudio investigado y contrastado con la eficacia relativa del descubrimiento guiado, la demostración y el método de lectura tradicional de enseñanza sobre los logros de los estudiantes en el movimiento de rotación. En el Grado 11 los estudiantes de tres escuelas preparatorias seleccionadas en la zona Ilu Aba Bora localizada en la parte suroeste de Etiopía tomaron parte en el estudio. El diseño de la investigación específica adoptada en el estudio fue un diseño pretest-postest experimental de grupos de control no aleatorios. Una muestra de diseño intencional fue usada para seleccionar tres escuelas preparatorias de seis escuelas preparatorias en la zona. El proceso de investigación se llevó a cabo en el salón de clases natural. El decubrimiento guiado, demostración y los métodos tradicionales fueron implementados en Mettu, Yayo Aida Thea Gore y escuelas secundarias y preparatorias, respectivamente. El número total de estudiantes que participaron en el estudio fueron 114 comprendiendo de 73 hombres y 41 mujeres. La investigación desarrollada de la prueba física lograda (RDPAT) con una consistencia interna de 0.77 utilizando la fórmula de Kuder-Richardson 20 para pre-test y post-test de 0.80 fue utilizado como instrumento de recolección de datos en el estudio. El resultado del primer semestre de los estudiantes que tomaron parte en el estudio fue también utilizado para las listas de los estudiantes y establecer la validez construida de RDPAT. Las pruebas estadísticas utilizadas en el estudio fueron la media y la desviación estándar, ANCOVA, t-test, ANOVA, Scheffé pos hoc test, Cohen's d y los tamaños de efecto η^2. La prueba Kolmogorov-Smimov fue utilizada para la prueba de normalidad de los puntajes postest, lo cual es una suposición clave en t-test y ANOVA. Análisis con ANCOVA y la prueba de Scheffé mostraron que el método de descubrimiento guiado fue el método de enseñanza más eficaz (con una puntuación de ganancia media de 0.43) seguido por la demostración (puntaje de la ganancia media de 0.34). El método tradicional resultó ser el menos efectivo (puntaje promedio de ganancia de 0.26). El análisis estadístico usado a fondo por los estudiantes. El valor R cuadrado indica que aproximadamente el 57% de la variación total en el logro de los estudiantes en dinámica del movimiento de rotación puede ser atribuida a los métodos de enseñanza específicos empleados. No hubo una diferencia significativa entre el rendimiento de los e4studiantes hombres y mujeres que fueron enseñados con el decubrimiento guiado, la demostración y el método tradicional. Hubo una diferencia significativa entre los rendimientos de cada par de calificaciones de los estudiantes de alto, mediano y bajo puntaje cumplido por los estudiantes a quienes se les enseñó con el descubrimiento guiado y la demostración. Esto implica que el logro de los estudiantes tiene una fuerte relación con sus niveles de desarrollo base (alto, medio y bajo logros) además del efecto de los métodos de instrucción. Se recomienda que los profesores de Física en la zona deben implementar descubrimientos guiados con suficiente orientación para ayudar a los estudiantes a crear, integrar y generalizar los conocimientos a través de la solución de problemas constructivistas proporcionando los materiales disponibles en el laboratorio de física o localmente preparados materiales de enseñanza.

Palabras clave: Descubrimiento guiado, demostración, logros físicos, escuelas preparatorias.

PACS: 01.40.-d, 01.40.Fk, 01.40.gb **ISSN 1870-9095**

I. INTRODUCTION

The primary goal of science education is to enable us to construct knowledge of how our universe works, in order to explain, and possibly control phenomena [1]. To achieve this goal, we need to educate our students in a way that they become competent. To accomplish this, the methods employed in teaching/learning in schools are of vital importance. Many educators consider methodology of teaching as the central concern of a teacher [2]. A possible reason for this may be that a teacher's knowledge of the subject matter alone does not guarantee to carry on an effective teaching/learning process. Although there is no best method of teaching/learning in the educational system, there is a choice of one method over the other due to the nature of the learner, the content and the desired outcomes of the lesson [1, 2]. When seen from the positivists view of objective reality, the role of the teacher is to transmit his knowledge to the students. Alternatively, constructivists hold that individuals actively construct their own reality in an effort to make sense of their experience [3]; an effective learning in science is interactive, involving the learner in constructing ideas as a result of experiences [4, 5]. This implies that according to constructivists reality is determined by the experience of the knower and is therefore personal and subjective [6, 7]. The central idea of constructivists is the notion that reality is determined by the experience of the knower. The assertions pivotal to constructivist epistemology are considering knowledge as a way of making sense of experience and as an interpretation open to uncertainty that is based on prior knowledge [8].

These epistemological foundations led constructivists to the conclusion that knowledge is a personal construction rather than imparted from a teacher; constructivism in classroom incorporates three important dimensions: (1) valuing the student's point of view, (2) using higher-level questions to elicit student thoughts, and (3) valuing the process of student thinking rather than student answer or product [9]. Providing greater opportunity to students to share their opinion, value opinion of others, developing consensus among class fellows on the various opinion raised, and appreciate new scientific ways of describing phenomena are the major domains that affect classroom practices upon applying constructivist principles [10].

According to constructivism, the centre of instruction is the learner [11] and its approach is to work with the children, helping them to develop their own models. It is not good enough to teach them to give a superficial appearance of advanced knowledge.

The notion that pupil learning is more meaningful, more thorough, and therefore usable when pupils seek out and discover knowledge, rather than just being receivers of knowledge, has been held by educational theorists for centuries. One such method is the discovery method of learning. Discovery learning is intentional learning through problem solving under teacher supervision [12]; is a method through which teacher provides illustrative materials for students to study on their own [13].

Discovery learning is usually carried out in groups and is dependent on pre-existing knowledge. The method is an inductive method of guiding pupils to discuss and organize ideas and processes by themselves [14] and during guided practice, the teacher invites students to initiate discussion and to react to other students' [15]. Guided discovery learning can be used if learners can puzzle out the new learning from their existing knowledge and experience. Learners' background knowledge, techniques and understanding of what is expected of them are most important considerations for the effective guidance [16].

Providing each student with opportunity to find solution to a problem personally or in group increases the students' responsibility for what they do [17]. A central strategy for constructivism is to create a collaborative learning environment among the learners [11]. The implementation of such method in science class requires more teacher's planning and direction [1]. Alexander [18] suggests that the implementation of guided discovery requires a considerable amount of advanced planning of the teacher's part.

II. THE PROBLEM

The Ethiopian National learning assessments showed that compared to other subjects students' performance in physics to be the least in all grade levels [19, 20]. Of course, many factors may influence students' performance. However, according to Garcia [2], one's teaching effectiveness may greatly increase depending on one's ability to make a choice of appropriate teaching method. Educators have different views on the effectiveness of direct instructional approaches in which the role of the teacher is dominant, and the student-centered indirect approaches. The major difference between these two approaches is on the importance of guidance to the learners or on the degree of guidance if there is some. For instance, upon comparing guided versus unguided instruction, Kirschner *et al*. [21] wrote unguided or minimally guided learning approaches "are less effective and less efficient than learning approaches that place a strong effort on guidance of the student learning process" in favor of the direct instruction approach. While the constructivist student-centered approaches are advocated by educators [13, 22, 23]. As such, the focus of this research is to identify which of the method(s) underlying these instructional approaches contribute to a better success of students' achievement in physics in particular focus to Ilu Aba Bora Zone. The particular teaching methods in focus are the guided discovery – rooted on constructivist approach, and demonstration method – rooted on direct instruction approach.

In addition to the choice of appropriate teaching method, a gender balanced physics instruction is also equally important for the success of the students. According to McKinnon and Potter [24], reducing gender bias and performance differences while increasing all students' conceptual understanding of a subject is an important consideration of pedagogical style.

III. RESEARCH QUESTIONS AND HYPOTHESES

This research was guided by the following research questions. (1) Do sample students' average scores in physics differ significantly after receiving the interventions (guided discovery & demonstration methods)? (2) Are there differences between the average physics scores of males and females in the sample after receiving the interventions? (3) Are there differences between the three performance levels (high, medium, low) in the sample with regard to their average scores after receiving the interventions? Based on these research questions, the following null hypotheses were formulated.

H_{01}: There is no significant mean difference on the physics achievement between students in the experimental groups and those in comparison group.

H_{02}: There is no significant mean difference on the physics achievement between male and female students.

H_{03}: There is no significant mean difference on the posttest physics achievement between the low-, medium, and high-achiever students.

IV. PURPOSE OF THE STUDY

The purposes of this study were to (1) compare the relative effectiveness of guided discovery and demonstration methods in improving students' physics achievement in dynamics of rotational motion; (2) identify gender difference towards each of the methods and their corresponding improvement in achievement of dynamics of rotational motion; and (3) investigate the effect of each methods on the low-, medium, and high-achiever students' physics achievement in dynamics of rotational motion

V. METHODOLOGY

A. Research Design

The research design used in the study was a quasi-experimental design. Specifically nonrandomized pretest-posttest design was used. This design is often used in classroom experiments when experimental and control groups are in their natural classroom setting which cannot be disrupted for the research purpose.

B. Sample and sample size

The target population in this research was grade 11 preparatory students of natural science stream in Ilu Aba Bora zone, which is located at Southwestern part of Ethiopia in Oromia Regional State at 600km from the capital Addis Ababa. Purposive sampling technique was used to select three schools out of six preparatory schools in the zone. The criteria for the selection were: proximity between schools and availability of transportation, the availability of functional physics laboratory, matching number of students in a class. The sample sizes used in the research were (M=24, F=12) for guided discovery; (M=26, F=10) for demonstration; and (M=23, F=19) for the comparison group.

Data collection during the research involved two phases: (1) the administration of the pretest to identify students' background knowledge, (2) the administration of the posttest after the treatments. During the treatment, students in the experimental groups (guided discovery and demonstration) did the same activities selected from grade 11 physics textbook. Students in the guided discovery did the activities for themselves under the guidance of the teacher while in demonstration, they were shown ready-made experiments.

C. Research Procedures

To compare the relative effectiveness of the teaching methods, physics achievement test was developed and pilot tested before use. The pilot study was administered to thirty-eight students in Bedele Secondary and Preparatory School as they were taken from same population with relatively similar environmental setting and educational background as that of the research samples. The participants in this study were selected from three government schools in Ilu Aba Bora zone, Oromia region, located at southwestern part of Ethiopia. The schools chosen were Mettu, Yayo Aida Thea, and Gore Secondary and Preparatory Schools. The schools were randomly assigned to each of the treatments. Based on this, Mettu Secondary School was assigned to Guided Discovery, Yayo Aida Thea Secondary and Preparatory School was assigned to the Demonstration, and Gore Secondary and Preparatory School was assigned to the comparison group. The research procedure consisted of three phases. The first phase was the administration of the pretest to identify students' background knowledge. The second phase was administering the different teaching methods. During the treatment, students in the experimental groups (guided discovery and demonstration) did the same activities selected from grade 11 physics textbook. Students in the guided discovery did the activities for themselves under the guidance of the teacher while in demonstration, they were shown ready-made experiments. The third phase was the administration of the posttest after the treatments.

VI. FINDINGS

A. Students Achievement Difference before intervention

The result of the Scheffé test shown in Table I illustrates that there was no significant mean difference of the pretest in all possible combinations of the three groups. For all cases $p > 0.05$. Here we can clearly see that there is no significant baseline difference. Even if there is a significant difference in the baseline, the ANCOVA test makes an adjustment for pre-existing differences as long as it is not large [30]. With this prerequisite, we can now move onto hypothesis testing using ANCOVA and other tests.

TABLE I. Scheffé post hoc test for pretest scores.

(I)AL	(J)AL	MD(I-J)	SE	Sig.	95% CI	
					LB	UB
Dem.	GD	-2.556	3.93	0.81	-12.31	7.20
	Tr	6.619	3.79	0.22	-2.78	16.02
GD	Dem.	2.556	3.93	0.81	-7.20	12.31
	Tr.	9.175	3.79	0.06	-0.22	18.57
Tr.	Dem.	-6.619	3.79	0.22	-16.02	2.78
	GD	-9.175	3.79	0.06	-18.57	0.22

Dem. = Demonstration; GD = Guided Discovery, Tr. = Traditional method of teaching.

B. Hypothesis Testing

A. Effect of teaching methods on Students' achievement

H_{o1}: There is no significant mean difference on the physics achievement of the students after being taught with the different methods (*i.e.*, guided discovery, demonstration, and the traditional teaching method)

TABLE II. ANCOVA test result of students posttest score (α =.05), dependent Variable: Posttest.

Source	SS	df	MS	F
Pretest	12210.49	1	12210.49	76.89*
Method	5730.29	2	2865.15	18.04*
Error	17468.93	110	158.81	
Corrected Total	40424.11	113		

R squared = 0.57, Adjusted R squared = 0.56, * $p < 0.05$.

ANCOVA table shows significant F value for the teaching methos employed ($F = 18.04$, $p<.05$). Therefore, the null hypothesis stating, "There is no significant mean difference on the physics achievement of the students after being taught with the different methods (*i.e.*, guided discovery, demonstration, and the traditional teaching method)" was rejected.

The R squared value indicates that approximately 57% of the total variance in the achievement of the students in dynamics of rotational motion can be attributed to the specific teaching methods employed. However, this result doesn't tell us which method of teaching is most significant. For this purpose Scheffé's multiple comparison test was run and presented in Table III.

TABLE III. Scheffé's multiple comparison test, dependent Variable: Posttest.

(I) Method	(J) Method	MD(I-J)	SE	95% CI	
				UB	LB
Dem.	GD	-10.30*	3.85	-19.87	-0.74
	Tr.	13.09*	3.71	3.88	22.31
GD	Dem.	10.30*	3.85	0.74	19.87
	Tr.	23.40*	3.71	14.19	32.62
Tr.	Dem.	-13.09*	3.71	-22.31	-3.88
	GD	-23.40*	3.71	-32.62	-14.19

* $p <.05$.

The results of the Scheffé test shown in Table III indicates that students in the guided discovery group (M=67.14, SD=11.818) achieved better than the comparison group (M=43.74, SD=19.308) with an effect size of (d=1.46). Students in the demonstration group (M=56.83, SD=16.481) showed a better achievement than the comparison group (M=43.74, SD=19.308) with a moderate effect size of (d=0.73). This indicates that the guided discovery was the most effective of the methods used followed by demonstration method.

B. Effect of Gender on Students' Achievement

H_{o2}: There is no significant mean difference on the physics achievement of male and female students after intervention.

TABLE IV. t-test comparison of posttest mean scores of males and females.

Group	Sex	N	Mean	S.D.	t	df	*p* (2-tailed)
GD	M	24	68.46	12.9	0.95	34	0.35
	F	12	64.50	8.9			
Dem	M	26	58.35	16.9	0.89	34	0.38
	F	10	52.90	15.4			
Tr	M	23	44.48	19.85	0.27	40	0.79
	F	19	42.84	19.14			

Table IV shows that in a guided discoover method of teaching the achievement of male students (M=68.46, SD=12.9) did not show any significant difference with that of female students' (M=64.5, SD=8.9), t(34)=0.946, *p*=0.351, η^2=0.026, two-tailed. We similarily see from the table that there is no significant mean difference on the physics achievement of male and female students after being taught with demonstration method. That is, the achievement of male students (M=58.35, SD=16.9) did not show any significant difference with that of female students' (M=52.90, SD=15.4), t(34)=0.885, *p*=0.382, η^2=0.023, two-tailed. Further more, tha table shows that the achievement of male students (M=44.48, SD=19.85) did not show any significant difference with that of female students (M=42.84, SD=19.14), t(40)=0.270, *p*=0.788, η^2=0.002, two-tailed, in a traditional method of teaching. Therefore the null hypothesis which states "There is no significant mean difference on the physics achievement of male and female students after being taught with different methods" is retained.

C. Relationship between students Performance Level and their posttest scores

H_{o5}: There is no significant mean difference on the posttest physics achievement of low-, medium, and high-achiever students after being taught with different methods.

TABLE V. ANOVA test comparison of posttest mean scores of high-, medium-, and low-achiever students.

Meth.	SV	SS	df	MS	F	η^2
GD	BG	2743.65	2	1371.83	21.11*	0.56
	WG	2144.65	33	64.99		
	Total	4888.31	35			
Dem	BG	5918.22	2	2959.11	27.21*	0.61
	WG	3588.78	33	108.75		
	Total	9597.00	35			
Tr	BG	7893.24	2	3946.62	20.83*	0.52
	WG	7390.88	39	189.51		
	Total	15284.12	41			

*$p < .05$

Table V shows that there is a significant mean difference between the posttest scores of high-achiever students (M=77.91, SD=7.943), medium-achiever students (M=68.67, SD=8.128), and low-achiever students (M=56.62, SD=8.099) taught with guided discovery method with F(2,33)=21.108, p<0.05, η^2=0.56. There is also a significant mean difference between the posttest scores of high-achiever students (M=74.60, SD=8.113), medium-achiever students (M=58.33, SD=11.703), and low-achiever students (M=42.86, SD=10.705) taught with demonstration method with F(2,33)= 27.210, p<0.05, η^2=0.61. The table further shows a significant mean difference between the posttest scores of high-achiever students (M=69.78, SD=19.363), medium-achiever students (M=38.32, SD=12.504), and low-achiever students (M=34.36, SD=11.015) taught with traditional teaching method with F(2,39)= 20.825, p<0.05, η^2=0.52. To see which level of performance is benefited from which teaching meethod, Scheffé's multiple comparison test was run and presented in Table VI.

The results of Scheffé pair-wise comparison test shown in Table VI shows that there were a significant mean difference among the posttest scores of high-, medium-, and low-achiever students after being taught with the guided discovery method and demonstration method. For students exposed to traditional method of teaching, there were significant mean differences among the posttest mean scores of high-, and medium-achiever students as well as between high-, and low-achiever students' posttest scores taught with the traditional teaching method (p < 0.05).

TABLE VI. Scheffé's multiple comparison test for high-, medium-, and low-achiever students' posttest scores.

Method	(I)AL	(J)AL	MD(I-J)	SE	95% CI	
					LB	UB
GD	H	M	9.24*	3.37	0.62	17.87
		L	21.29*	3.30	12.83	29.76
	M	H	-9.24*	3.67	-17.87	-0.62
		L	12.05*	3.23	3.78	20.32
	L	H	-21.29*	3.30	-29.76	-12.83
		M	-12.05*	3.23	-20.32	-3.78
Dem.	H	M	16.27*	4.47	4.82	27.71
		L	31.74*	4.32	20.68	42.81
	M	H	-16.27*	4.47	-27.71	-4.82
		L	15.48*	4.10	4.96	25.99
	L	H	-31.74*	4.32	-42.81	-20.68
		M	-15.48*	4.10	-25.99	-4.96
Tr.	H	M	31.46*	5.57	17.29	45.64
		L	35.42*	5.88	20.45	50.39
	M	H	-31.46*	5.57	-45.64	-17.29
		L	3.96	4.85	-8.38	16.30
	L	H	-35.42*	5.88	-50.39	-20.45
		M	-3.96	4.85	-16.30	8.38

**p <.05; H = high, M = médium, L = low*

D. Hake's Average Gain Score Analysis

The statistical significance tests such as ANCOVA and Scheffè have shown that the difference between the effects of the methods used were not due to chance. The Hake's normalized average gain score is used to assess the magnitude of the differences on students' gain scores due to the effects of the teaching methods employed [25]. The correlation coefficient (r) between each students' normalized Hake's gain score with their pretest score was 0.08, p = 0.40, two-tailed. Absence of correlation between pre-instructional scores and average gain score as a measure of learning justifies that the measure of average gain score is independent of a student's initial state of knowledge [26]. The Hake's average gain score analysis showed that the students in the guided discovery ($\langle g \rangle_{av}$ =0.43) had the largest gain score followed by demonstration method ($\langle g \rangle_{av}$ =0.34). Students in the traditional method received the least gain score ($\langle g \rangle_{av}$ =0.26).

VII. DISCUSSION OF RESULTS

The Scheffè test was conducted to see the magnitude of pair-wise differences of the pretest scores of the three groups. The result of the Scheffè test revealed that the mean difference was statistically insignificant for every pair of the groups. The magnitude of the differences varies among the pairs. As such, the analysis of covariance (ANCOVA) is used to statistically control such small baseline differences. The ANCOVA analysis and results of the study showed that there was a significant difference on the achievement of students after taught with guided discovery, demonstration and the traditional method. A multiple regression index (R) of 0.755 with a multiple regression index squared (R^2) of 0.57 was obtained. This implies that 57% of the total variance in the achievement of students in dynamics of rotational motion is attributed to the effect of the teaching methods employed. Analysis of the Scheffè test showed that guided discovery was the most effective in improving students' achievement in dynamics of rotational motion. It also showed that the demonstration method was the second effective method while the traditional method was found to be the least effective method in improving students' achievement in dynamics of rotational motion. Akinbobola and Afolabi [13] did a comparable study in which the effect of guided discovery, demonstration and expository method on cognitive achievement on Nigerian senior secondary school physics after the students were exposed to pictorial organizer was studied. In the study they found (R=0.91, R^2=0.83) which indicates that the methods had strong effect with 83% of the total variances in their achievements being attributed to the teaching methods. Mayer [27] reviewed research evidences from 1960s to 1980s comparing pure discovery versus guided discovery and concluded the importance of instructional guidance rather than pure discovery. Similarly, the research conducted by Bukova-Güzel [28] on the effect of a constructivist learning environment on the limit concept among mathematics student teachers showed that it provided positive contribution to learning of the limit concept.

The finding in this study may be due to the students' motivation towards the guided discovery method. According to Sola and Ojo [29] respect of students' opinion during discussions motivate students and enable them to discover that knowledge does not belong to only a person but something they can also create for their own. In problem-oriented lessons students show interest when they are faced with puzzle [13]. According to Garcia [2] if the learner knows that he can find out things for himself, he feels that he can achieve something and can experience some amount of success. Educators also agree that personally discovered knowledge last significantly longer time than knowledge imparted from teacher through any means as discovery involves an internalization of knowledge (*ibid*). The analysis of the t-test revealed that neither the treatments nor the traditional (regular) teaching method discriminated between the performance of males and females. Before the treatments, the students were categorized as high-, medium-, and low-achiever based on their previous semester results. The Scheffè test of the posttest mean scores after the treatments showed that there was a significant mean difference among the high-, medium-, and low-achiever students in the guided discovery and demonstration method. The Scheffè test of the comparison group revealed that only high-achiever students, as compared to medium-, and low-achiever students, showed a significant mean difference during the posttest.

To sum up, the findings the current study indicated that:

(1) The guided discovery is more effective in improving students' achievement followed by demonstration method while the traditional method is the least effective.

(2) There is no significant difference in the achievement of male and female students in physics after being taught with guided discovery, demonstration or the traditional method.

(3) The students' achievement has a strong relationship with their background performance levels (high-, medium-, and low-achiever) besides the effect of the instructional methods.

REFERENCES

[1] Carin, A. A., *Teaching Modern Science*, 7th Ed. (Prentice-Hall, Inc. Ohio, 1997), p. 5, 62.

[2] Garcia, M. B., *Focus on Teaching: Approaches, Methods and Techniques*, (Rex Printing Company, Inc., Manila, 1989), pp. 21, 29 and 40.

[3] Prince, M. J. and Felder, R. M., *Inductive teaching and learning methods: Definitions, comparisons, and research bases*, Journal of Engineering Education **95**, 123–138 (2006).

[4] Driver, R., *The Pupil as a Scientist*, (Open University Press, Buckingham, 1983).

[5] Von, E. G., *Radical Constructivism: A Way of Knowing and Learning*, (Falmer, London, 1995).

[6] Lai-Chong, L. and Ka-Ming, W., *Implications and Problems of Constructivism for Instructional Design*, The Chinese University of Hong Kong **23**,73–104 (1996).

[7] Tobin, K. and Tippins, D., *Constructivism as a Referent for Teaching and Learning*, (Lawrence Erlbaum associates, Inc., Hillsdale, NJ, 1993).

[8] Mohan, R., *Innovative Science Teaching: For Physical Science Teachers*, 3rd Ed. (Prentice-Hall of India, New Delhi, 2007), p. 106.

[9] Freiberg, H. J., *Driscoll, Amy, Universal Teaching Strategies*, 2nd Ed. (A Simon & Schuster Company, Needham Heights, 1996), p. 297.

[10] Mahmood, N., *Elementary School Science Teachers' Belief about Science and Science Teaching in Constructivist Landscape*, IER, University of the Punjab, Lahore, Pakistan **29**(2), 59-72 (2007).

[11] Karagiorgi, Y. & Symeou, L., *Translating Constructivism into Instructional Design: Potential and Limitations, Educational Technology & Society* **8**, 17-27 (2005).

[12] Kasambira, K. P., *Lesson Planning and Class Management*, (Longman Group; UK, 1993), p. 46.

[13] Akinbobola, A. O. & Afolabi, F., *Constructivist Practices through Guided Discovery Approach: The Effect of Students' Cognitive Achievement in Nigerian Senior Secondary School Physics*, Eurasian Journal of Physics and Chemistry Education **2**, 16–25 (2010).

[14] Acero, V. O., Javier, E. S., Castro, H. O., *Principles of Teaching*, (Rex Printing Company, Inc., Manila, 2000), p. 96.

[15] Murray, F. B. and Raths, J., *Review of Educational Research*, AERA Publication Department **64**, 480 (1994).

[16] Petty, M. A., Lackey, N. R. and Sullivan, J. J., *Making sense of factor analysis: The use of factor analysis in instrument development in health care research*, (Sage Publications, Inc., London, 2003), p. 299.

[17] Klausmeier, H. J., *Principles and Practices of Secondary School Teaching*, (Harper and Brothers Publishers, New York, 1953), p. 410.

[18] Alexander, W. M. and Halverson, P. M., *Effective Teaching in Secondary Schools*, (Rinehart and Company Inc., New York, 1956), p. 429.

[19] Ministry of Education, Ethiopian Third National Learning Assessment of Grade Eight Students, General Education Quality Assurance and Examinations Agency, (Addis Ababa, 2008), p.44.

[20] Ministry of Education, Ethiopian First National Learning Assessment of Grades 10 and 12 Students, (National Agency for Examinations, Addis Ababa, 2010), p. 13.

[21] Kirschner, P., Sweller, J. and Clark, R. E., *Why unguided learning does not work: An Analysis of the Failure of Discovery Learning, Problem-Based Learning, Experiential Learning and Inquiry-Based Learning*, (Open University of the Netherlands, The Netherlands, 2004).

[22] Akinbobola, A. O., *Constructivist Problem Based Learning Technique and the Academic Achievement of Physics Students with Low Ability Level in Nigerian Secondary Schools*, Eurasian Journal of Physics and Chemistry Education **1**, 45–51, (2009).

[23] Liang, L. L., Gabel, D. L., *Effectiveness of a Constructivist Approach to Science Instruction for Prospective Elementary Teachers*, International Journal of Science Education **27**, 1143–1162 (2005).

[24] McKinnon, M. L. and Potter, W. H., *Preliminary results of gender equity variations in a large active-learning introductory physics course due to laboratory activity instructions*, (In Marx, J. Heron, P. and Franklin, S.: Physics education research conference, American Institute of Physics, Sacramento, California, 2004), p. 129.

[25] Hake, R. R., *Analyzing Change/Gain Scores*, (Dept. of Physics, Indiana University, 1999), p. 1.

[26] Coletta, V. P., Phillips, J. A. and Steinert, J. J., *Why You Should Measure Your Students' Reasoning Ability*, (The Physics Teacher, Auburn, 2007), p. 235.

[27] Mayer, R. E., *Should There Be a Three-Strikes Rule Against Pure Discovery Learning? The Case for Guided Methods of Instruction*, American Psychological Association, Inc. **59**, 14–19 (2004).

[28] Bukova-Güzel, E., *The Effect of a Constructivist Learning Environment on the Limit Concept among Mathematics Student Teachers,* (EDAM-Education Consultancy Limited, Turkey, 2007), p. 1192.
[29] Sola, A. O. and Ojo, O. E., *Effects of project, inquiry and lecture-demonstration teaching methods on senior secondary students' achievement in separation of mixtures practical test*, Educational Research and Review **2**(6), 124–132 (2007).
[30] Hinkle, D. E., Wiersma, W. and Jurs, S. G., *Applied statistics for the behavioral sciences*, 3rd Ed. (Houghton Mifflin Company, Boston, 1994).