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The Effect of Teaching Optics Physics Based On Directed Inquiry Strategy on the Tenth Grade Students' Achievement and Their Attitudes toward the Subject

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Abstract
This study aimed to investigate the effect of teaching optics physics based on directed inquiry on the tenth grade female students' achievement and attitudes toward the optics as a branch of physics in jordan. to achieve this aim, a quasi-experimental approach with a pre/post- test, was designed to examine the effect of the independent variable (teaching strategy / ordinary method) on the dependent variables (scientific achievement and attitudes of students toward optics physics). The study used two instruments for data collection, the first; achievement test.this test included in the final version (30) items of multiple choice with four alternatives, difficulty and discrimination coefficient of the test was calculated as well as the face and content validity and reliability was verified. and the second; was the scientific attitudes measure. this measure consisted of (25) items and a five-level likert scale used to determine the degree of attitudes. face and content validity and reliability of the measure were verified.The results of the statistical analysis demonstrated that there was a statistically significant difference in favor of the experimental group for both dependent variables (the achievement and the scientific attitudes).these results mean that teaching according to the directed inquiry strategy caused a significant impact on improving the achievement levels and the attitudes of students toward the subject of optics physics.In light of the study results, the researchers recommended using the directed inquiry in teaching optics as it improves their work and promotes the positive attitudes of students.
Key words: directed inqury strategy, achievement, attitudes, optics physics.

INRODUCTION

The world is facing nowadays a number of successive scientific and technical challenges that have an impact on educational systems, and these challenges and changes make it necessary for educators to reconsider the educational process in general in order to keep pace with community needs and enable individuals to adapt to the environment and social and economic situation.

To adapt to such developments, it calls for teachers to possess different life skills and employment of modern teaching strategies in every area of science, for the purpose of the advancement of the educational learning process and establishing them according to the principles and aims of making the learner the basic building block in the educational system and bringing out his/her capabilities to be an active member in society (Faraj & Muhaimi, 1999).

The physics of optics as a branch of general physics that deals with the light and its properties and its practical applications in optics is not different from the other sciences in teaching by teachers and employing modern methods and strategies in the delivery of material efficiently and effectively in order to achieve desired behavioral changes in the learner.

The applications of the physics of optics, especially the topics of optics include visible spectrum r, electromagnetic spectrum, such as X-rays, gamma waves, radio waves and microwave radiation. And for this reason , the optics branch is considered one of the branches of electromagnetic science, which is based mainly on the principles of Maxwell's equations and optics is a branch of physics and engineering concerned about the properties of light such as how to produce light, and its transmission, and detecting, measuring and using it.

Optics also studies the visible light, infrared and ultraviolet radiation, which cannot be seen with the naked eye. A lot of equipment, such as optical microscopy, electron microscopy and imaging machine and amplifiers and a telescope, work in accordance with the principles of Optics. This equipment contain optical devices, such as lenses and mirrors that transmit light and control it ,in addition to that the light can be tracked and measured by

its own measures.

Generally, the methods and strategies for teaching science in all its branches, including the physics of optics are derived from philosophies and slogans such as: "teach the learner how to learn" and "teach the learner how to think," and "teach the learner the inquiry skills" which have their applications and importance in contemporary education in terms of its impact on the development of thinking and the active learner in the acquisition of educational experiences.

The research results and educational studies in the last two decades of the twentieth century, confirm the importance of training teachers to use new strategies in teaching, such as cooperative learning, discovery learning, problem- solving, role-playing, brainstorming, and inquiry. These strategies emphasize the activity of the learner, and his/her willingness to work with others to achieve objectives related to his/her overall growth. The use of such strategies which focus while teaching on physical and mental activity of the learner is a method suitable for preparing students for life as part of the challenges of the local and global changes. There is no doubt that finding a capable teacher who can achieve such tasks requires an effort by those in charge of teacher preparation and training, both pre- service and in-service (Zughreb,1990).

The essence of inquiry learning is in the teacher's ability to build educational learning situations through which the content of the curriculum is transferred to the problems that evoke students' interest and desire to inquire and research for knowledge. The inquiry is considered one of the important teaching methods in the teaching of physics, including the optics, due to its effectiveness in increasing learning outcomes. It also enhances the strategies of scientific research to observe and gather information, organize information and to identify variables, and formulating hypotheses and then testing and interpretation of results. This kind of learning enhances the learning values and trends in scientific and creative thinking. It can be used with all age groups in all stages of school education and higher education depending on the difficulty and ease of the problem and the characteristics of students in each stage determined by the teacher (Abdelsalam, 2001).

The inquiry learning achieves a number of educational goals that work together and affect each other, and most importantly the ability to self-learning development, the idea of lifelong learning, and the consolidation of learning based on their own practice, enhancing self-confidence in the learners, self-realization and collaborative learning .The inquiry learning helps in the development of discovery skill in the student's ability to various sources of knowledge, such as books, periodicals, documents, movies, museums and others. It develops the ability to identify the sources of information and how it was collected. In addition to improving the skill of writing reports, research and investigations, and the ability to make decisions, and evaluating and justifying based on correct information. And it develops and increases the student's self-confidence and self-reliance, and the planning skill and information gathering and processing (Almuhaisen, 2007)

In addition, the inquiry approach fosters positive attitudes towards study courses. These trends contribute to increase the learning ability as a behavioral aspect in the learner in all fields, particularly physics of optics where the developed countries are seeking to gain access to its secrets and properties; being a science containing the secrets of energy, atom laser, etc…..., as it seeks through inquiry learning to reach a degree of understanding and perception of learners.

As physics is considered one of the most difficult courses to students, making them avoid it as they have negative attitudes towards it; therefore the number of students who study it is less than those studying other courses, and the success rate in physics is less than the success rate in chemistry and biology (Erdemir, 2009).

Attitudes are explained as the positions taken by the individual positively or negatively towards a particular issue, such as the importance of scientific knowledge in the life of the individual. The scientific attitudes are considered as factors motivating female students to the study of science, and it is also assists in the acquisition of scientific ideas and scientific skills and using them in new situations. (Zaitoun, 1988).

Attitudes consist of interconnected elements can be grouped together to finally give a cognitive and emotional behavior, and of these components

1. The component of knowledge: It relates to the knowledge of the individual and his/ her ideas and beliefs about the facts related to the subject of the attitude. The individual with scientific attitudes show an understanding of

science and its development stages and its goals and objectives, characteristics and importance in life.
2. Emotional component: the individual's sense of acceptance or rejection, love and hate for the subject. It pushes the individual on the subject that feels comfortable for him.
3. Behavioral component: it includes a set of behavioral preparations relating to the actions of the individual and the response and behavior towards a particular topic and scientific attitudes directs the individual towards a particular behavior according to a preferential position of acceptance or rejection.

As seen above, we can see the individual attitudes toward things or situations as the individual may take a certain position towards a science or a positive attitude or a negative one toward things or science, etc…

RESEARCH PROBLEM

Through academic experience in university teaching and the in-service training of science teachers and field observations of researchers, we find that most teachers are still focusing on the traditional ways of teaching which mainly rely on lecturing and teacher-centered activities more than focusing on the student. Despite the changes that have occurred in modern educational trends and the accompanying developments in the strategies and teaching methods and techniques discussed in seminars and scientific conferences at the regional and local level, which confirm emphasize following learner-centered activities in the classroom and employing scientific thinking such as inquiry, problem solving and other skills. These modern strategies in teaching make focus on student in the educational process and look at he/she is a creative thinker who has the ability to develop achievement and attitudes toward learning subjects. This study comes to investigate the effect of a teaching Optics physics based on directed inquiry on the tenth grade female students' achievement and attitudes toward the optics as a branch of physics in Jordan

Research Questions

The Research Attempted To Answer The Main Question That:
What Is the Effect of Teaching Optics Physics Based On Directed Inquiry on the 10 Grade female Students 'Achievement and Attitudes toward the Subject in Jordan?
The Following Two Questions Were Derived From The Main Question:
1- What Is The Effect of Teaching Optics Physics Based on Directed Inquiry Strategy On the 10^{Th} Grade female Students' Achievement in Jordan?
2- What Is The Effect of Teaching Optics Physics Based on Directed Inquiry Strategy On the 10^{Th} Grade female Students' Attitudes toward the Optics Physics Subject in Jordan?

Significance of the Research

The Significance of the study stems from the nature of the subject matter of the research on the impact of the teaching of physics of optics according to the teaching based one strategy directed inquiry on the achievement of the tenth students and their attitudes towards the subject in Jordan, and due to the importance of this study on the theoretical practical levels.
For the theoretical importance of the study, it relied on the effect of directed inquiry strategy in the achievement of tenth students and their attitudes towards the subject and as the results may support new trends in the methods of teaching science as they provide new scientific knowledge and as it is an addition to the available scientific theory. Procedurally the results of the study will be of value to the trainers of physics teachers' workshops at the basic stage, in addition to curriculum planners who can benefit from the results of this study to emphasize this strategy in teaching the subject
At the research level, this study opens up other studies on different aspects and variables that are not addressed by the current study

Research Hypotheses

1-There is no statistical significant difference at (α=0.05) in the 10^{th} grade female students' achievement that can be attributed to the teaching strategy (Directed Inquiry and the Traditional).

2- There is no statistical significant difference at (α=0.05) in the 10^{th} grade female students attitudes toward the optics physics that can be attributed to the teaching strategy (directed Inquiry and the Traditional) .

Limitations of the Research

The generalization of the research results is limited to:

1. The students of tenth grade in the physics of optics course and therefore cannot be generalized to other classes and other courses.
2-The instruments used by the researchers and the psychometric characteristics associated with validity and reliability, and therefore cannot be guaranteed to reach the same results when using other instruments.
3. The impact resulted from the directed inquiry strategy in teaching as a treatment in the experimental group on (achievement and attitudes towards the physics of optics as dependent variables) and therefore cannot be guaranteed to reach the same results when using dependent other variables.
4. The subject of the physics of optics and therefore cannot be generalized to other physics topics.

Operational Definitions of the Research Terms :

Directed Inquiry Strategy

The directed inquiry strategy is activities and events the learner does under the supervision of and guidance the teacher, or within a research plan that has been prepared in advance. And this strategy often follows the steps which include identifying the problem by the teacher, writing possible hypotheses to solve the problem, the gathering of the information necessary to test hypotheses, and testing the hypotheses to solve the problem.

Achievement

It is intended as a procedural learning outcomes achieved by students of tenth grade after learning specific material on optics physics according to the of the directed inquiry strategy, and it is measured according to the grade obtained by the student in the achievement test that incorporates the knowledge and understanding and applications prepared by the researchers and developed for the purpose of this study

Attitudes toward the subject

Attitudes are defined as the mental and psychological preparedness of the learner towards a certain subject or something or a certain position, clearly shown through the individual's behavior in a positive or negative way toward that subject, where the response is characterized with stability and consistency to some extent. This attitude toward the subject is measured by the grade achieved by the learner bused on the measure that developed by the researchers.

Previous related studies:

Abu Qamar (1996) conducted a study that aimed to determine the effect of using the method of the directed inquiry compared with the traditional method on achievement of the eighth grade in science and on their attitudes toward them. The results of the study outweighed the directed inquiry strategy on the traditional method students in the achievement of students and attitudes towards science.

Sadiq (1998) conducted a study that aimed at investigating the effect of the research and inquiry method on teaching the units of light on the achievement and the acquisition of some of the basic science processes. The findings outweighed the research and inquiry method on the traditional way,

Al-Hakimi (2000) investigated the effect of using directed inquiry method on the achievement of biological concepts and retention of scientific knowledge among second secondary students in Aden. The study showed the superiority of the experimental group students over the control group in the achievement of biological concepts in general, and in the achievement each concept of biology.

Also Ahmad (2006) conducted a study that aimed to detect the effect of inquiry activities in the understanding and beliefs of students and their attitudes towards science. The results showed the superiority of inquiry activities method over the normal method in the understanding of the scientific concepts and the beliefs about science, but it did not have an impact on students' attitudes towards science.

Ayesh (2009) aimed to investigate the impact the inquiry activities on understanding of ninth-grade students of physical concepts, knowledge and beliefs about science. Results of the study showed that the experimental group outperformed the control group in the understanding of physics concepts, knowledge and beliefs about science.

Miqdad (2004) studied the effect of using the strategy of V-Shape maps to teach physics labs to science college students at Applied Science University on their achievement and attitudes towards physics. The study showed a statistical difference between the mathematical average of the students of the faculty of science who have studied the practical physics (1) by the map’s strategy of the V-shape (the experimental group), and the achievements

averages of their pears who have studied the subject in the traditional method (control group).The differences were in favor of the (experimental group). The study also showed statistical difference on the student's averages of the attitudes measurement towards physics related to the teaching-learning process, and the differences were in favor of experimental groups.

Comments on Previous Studies

After reviewing the previous studies related to the present study , it was observed that most of these studies concerned with identifying the effectiveness of teaching cognitive strategies and methods in general and inquiry techniques in specific to specify their effects on students achievement , attitudes toward subject matters and different kinds of thinking .

The previous studies pointed out some variations in the results in the dependent variables due to the effect on independent variable (teaching strategies). Also this study in consistency appeared the effect of using the directed inquiry as a cognitive strategy on students' achievement and their attitudes toward optics physics subject that they taught. However, the present study is considered complementary and integrated with those previous studies in terms of purpose and methodology. But the main difference which distinguish this study from the other studies due to the kind of the cognitive strategy (directed inquiry) used in teaching the optics physics subject to find its effect on students achievement and their attitudes toward the subject .

Research Approach and Procedures

Research Approach

To achieve the objectives of the study, a quasi-experimental approach with a pre/post- test, which is designed to examine the impact of the independent variable (teaching strategy) on the dependent variables (scientific achievement and attitudes toward optics physics) as it is the most convenient method of research.

Subjects of the study

The study subjects consisted of tenth grade students in government schools in the Capital, Amman. Khalda School for Girls of the Directorate of Education of Amman was chosen purposefully for the services and facilities provided by the school community for the implementation of the experiment. Two sections of tenth grade students were chosen randomly from the five sections to represent the experimental group which consisted of 34 students, which have been taught according to the directed inquiry strategy, where the second section to represent the control group which consisted of 32 students and was taught the same unit using the traditional method.

Study Instruments

The study included the following two Instruments for data collection:

First: Achievement test

It is an objective test that included the paragraphs of the information contained in the unit of the physics of optics from the Physics book for tenth grade, scheduled to be taught in the academic year 2015/2016, and the test was in the final version of (30) items of multiple choice with four alternatives, each paragraph measured included an objective related knowledge, remembering, understanding and comprehension and application. The test was developed according to the following steps:

- The content was analyzed in the Book of Optic physics.
- The researchers built a specification table to test the scientific concepts according to three cognitive levels (remembering, understanding and application)
- The test items in its first draft in accordance with the specifications table where the achievement test in its initial and final drafts consisted of 30 items in the form of multiple choice questions, and Table 1 shows the specification table for the test.

Correcting the achievement test:

The achievement test consisted of (30) items of multiple choice with four alternatives, with one mark for each correct answer, and the mark of zero for each wrong answer, The full mark of the test was (30).

The final draft of the test in the table of specifications, which shows the relationship between the content of the subject of the physics of optics and cognitive levels covered, was as follows.

Table (1) the specifications table for the achievement test in the subject of Physics of optics

Topic	Relative weights and the number of items	Remembering	Understanding and comprehension	Application	Overall test
The phenomenon of refraction of light	Relative weight	0.1	0.66	0.1	0.266
	Number of questions	3	2	1	6
The real dimension of the light	Relative weight	0.66	0.1	0.1	0.266
	Number of questions	2	3	1	6
Virtual dimension of light	Relative weight	0.13	0.66	0.66	1.45
	Number of questions	4	2	2	8
Total internal reflection and critical angle	Relative weight	0.66	0.1	0.66	1.42
	Number of questions	2	1	2	5
Refraction of light	Relative weight	0.1	0.66	0.66	1.42
	Number of questions	3	2	2	7
Total	Relative weight	0.4	0.33	0.26	0.99
	Number of questions	12	10	8	

Validity of the achievement test

To check the face and content validity of the achievement test, it was presented to seven experts and specialists in physics, optics, curricula and methods of teaching physics in some Jordanian universities, and three supervisors of physics and science in the Ministry of Education as to give their opinions and write notes about the test, and based on their feedback in terms of the clarity of the items and formulation, scientific accuracy of the test, and the diversity of the test items of the test levels, and its ability to measure the achievement of students. The necessary changes were made and (80%) degree of acceptance of the test items was approved.

Difficulty and discrimination coefficient of the test:

To find out the items characterized by their inability to distinguish between students as well as the items that are characterized as extremely difficult or extremely easy, the answers of the study sample were corrected then the difficulty factor for the test items was calculated using the following equations:

$$\text{Difficulty coefficient} = \frac{\text{The number of students who answered the item correctly}}{\text{Number of female students in the test}} \times 100$$

The discrimination factor for the items of scientific concepts was calculated according to the following equation:

$$\text{Discrimination factor} = \frac{\text{The correct answers of the higher level-correct answers of the lower level}}{\text{The number of students in one of the two levels}} X100$$

Table (2)

Values of difficulty and discrimination coefficient for the test items

Item No	Difficulty factor	Discrimination factor
1	0.51	0.37
2	0.43	0.62
3	0.62	0.43
4	0.57	0.81
5	0.48	0.41
6	0.64	0.63
7	0.43	0.47
8	0.32	0.42
9	0.21	0.79
10	0.43	0.47
11	052	0.51
12	0.31	0.42
13	0.43	0.51
14	0.59	0.43
15	0.45	0.47
16	0.34	0.61
17	0.62	0.77
18	0.58	0.64
19	0.57	0.63
20	0.26	0.54
21	0.43	0.55
22	0.34	0.43
23	0.61	0.39
24	0.72	0.72
25	0.57	0.49
26	0.46	0.43
27	0.35	0.46
28	0.54	0.77
29	0.53	0.63
30	0.42	0.43

Reliability of the Achievement test

To calculate the reliability coefficient, the researchers applied the test on a pilot sample that consisted of (41) female student from outside the study sample purpose of reliability calculation using the equation (Kudre, Richardson-20), which depends on the difficulty coefficient .The value of (0.89) was acceptable for the application of the instrument.

Second: The attitudes measure

The researchers used attitudes measure (questionnaire) that consisted of (25) items and a five-level Likert scale to determine the degree of approval of each item.

Validity of the measure

To examine the validity of the questionnaire, it was given to a group of judgers who have experience and specialization in the curricula and methods of teaching science and physics consisted (10) juries. They were asked to provide their opinion in terms of their suitability for the purpose prepared for it, and suitability in terms

of wording and its comprehensiveness. Appropriate modifications were carried out based on their suggestions and the item with (80%) agreement between judgers was adopted for the final version.

Reliability of the measure

To calculate the reliability of, the questionnaire, the (Test-Retest) was used and applied on (41) students of tenth grade chosen randomly from outside of the study sample, with a time of three weeks between the two applications Pearson Correlation Coefficient was calculated as the value of reliability coefficient between the pre- and post-test was (0.83) which is acceptable to apply the study tool.

Study design and variables:

The study included the following variables: -

1. Independent variable which included two levels:

Teaching strategy (directed inquiry and traditional method).

2. The dependent variables which include: -

(A) Achievement on the subject of optics physics.

(B) The attitude toward the subject of optics physics.

And that the study design is quasi-experimental design of two unequal groups with two tests pre- and post-tests, and can be expressed symbolically as follows:

EG : O O_1 x O O_1
CG : O O_1 - O O_1

The symbols can be illustrated as follows: -

EG: experimental group which applied the directed inquiry teaching strategy.
CG: control group which applied the traditional method.
O: pre- and post-achievement test
O1: attitudes towards the subject of optics physics.
X: the experimental treatment.
-No exposure to the experimental treatment

Results and Discussion

The following is a presentation of the results of the study according to their order as follows:

Results of the first question:

-What Is the Effect of Teaching Optics Physics Based On Directed Inquiry Strategy On the 10^{Th} Grade female Students Achievement In Jordan?

To answer this question, the means and standard deviations were calculated for the performance of students on the topic of optics physics test before the start of the experiment and after finishing it .the results showed in the following table**:**

Table (3)
Means and standard deviations for the achievement of students on the pre and post- test on the subject of optics for the experimental and control groups

Group (Teaching strategy)	size of sample	Pre-test		Post-test	
		Means	Standard deviation	Means	Standard deviation
Experimental(Directed inquiry)	34	12.55	1.97	23.91	3.48
Control)Traditional method)	32	10.12	2.84	13.41	3.01

Table(3) shows that there is equivalence between the means for the experimental and control group on the pretest reaching the experimental group (12.55) of the total (30) degrees and the control group reached (10.12). On the post-test, the means for the experimental group which studied according to the directed inquiry strategy reached (23.91) and difference of 10.5 degrees on the achievement of the control group which studied in the traditional method, with an average achievement of students in the test (13.41). For the purpose of verifying whether the difference between the average performance of the experimental group and the control group on the post- test had a statistically significant level (α=0.05) the analysis of covariance (ANCOVA) was used. The following table shows the result of statistical analysis:

Table (4)
Covariance analysis (ANCOVA) of the results of the experimental and control group in the optics achievement test

Covariance source	sum of squares SS	Degree of freedom DF	Means of sum squares MSS	Calculated Value (F)	Significance level
(Pre-test)	24.76	1	24.76	1.363	0.189
Teaching strategy	254.32	1	254.32	14.008	* 0.000
Error	1143.74	63	18.155		
Total	1422.82	65			

*Significance level(α=0.05)

Based on the results in the table (4) The value of (F) for the effect of teaching strategy on students' achievement in testing optics physics was (14.008) and at the level of significance was (0.000), and these values demonstrated that there is statistically significant a difference between the average achievement of students who studied according to the directed inquiry strategy and who studied in the traditional method. And since it means of the experimental group in the posttest was (23.91) and the control group was (13.41), this means that the difference was in favor of the group which studied according to the directed inquiry strategy, and for the purpose of investigating this difference and the position of the null hypothesis, the adjusted mean and standard errors were calculated for each of the experimental group and the control group on the achievement of students in the posttest in the subject of optics physics as a result of using of the analysis of covariance and the results are showed as in the following table:

Table (5)
Adjusted means and standard errors for the achievement on the optics physics Post-test the experimental and control group

Group	Adjusted means	Standard Error
Experimental (directed inquiry strategy)	23.98	0.81
Control (Traditional method)	14.01	0.92

The results of the statistical analysis of the difference between the adjusted means of the experimental group and control group demonstrates that there is a statistically significant difference in favor of the experimental group and based on this result, the first null hypothesis which states that "there is no significant difference at the level of(α=0.05)) to the students achievement that can be attributed to the strategy of teaching (the directed inquiry and traditional).

And approved the alternative hypothesis which states that there is a statistically significant difference is in favor of the experimental group that studied the subject of optics according to the strategy directed inquiry compared to the traditional way.

Based on these results, the Effect Size was calculated and the interpreted variation ratio of the impact of teaching strategy on the achievement tenth grade students in the subject of optics physics using (ETA $^2\eta$ square), as the results shown in the following table:

Table (6)
ETA SQUARE VALUE OF THE ATTITUDES OF TENTH GRADE STUDENTS ABOUT THE TOPIC OF OPTICS

Source of variation	sum of squares SS	$^2\eta$	Interpreted variation Ratio	effect size
Pre-test	24.76	0.0174	%1.74	Low
Teaching strategy (directed inquiry and traditional method)	254.32	0.1788	%17.88	High
Error	1143.74	0.8038	%80.38	
Total	1422.82			

The table shows that the effect of the teaching strategy was high with the value (0.1788) and this demonstrated that the teaching strategy caused a variation explaining the rate of (17.88%) of the total variation in the achievement of tenth grade students in the subject of optics physics, and this means that teaching according to the directed inquiry strategy caused a significant impact on improving the achievement levels of students as the higher mental skills that were used, might have a role in the achievement of the students, which was reflected on their performance, compared to the traditional way. The new activates used the directed inquiry strategy were met with enthusiasm and interest by students .These things might be the cause of enhancing the achievement of students .Also the students' feeling of self-confidence, and the desire to participate in activities and to express views in a manner based on thinking of issues in depth, might have an impact on developing thinking in many different ways, and this may not be available in the traditional way and therefore this might be the reason to increase the achievement of the students in the experimental group.

Results of the second question:
What Is the Effect of Teaching Optics Physics Based on Directed Inquiry Strategy On the 10Th Grade female Students' Attitudes toward the Optics Physics Subject in Jordan?

In order to answer the second question and examine the hypothesis derived from it, the means and standard deviations were calculated for the grades of students in the experimental group who studied according to the directed inquiry strategy and the control group which studied according to the traditional method, and the results of the attitudes measurements on the pre- and post-test were as follows:

Table (7)
Means and standard deviations of the students' attitudes toward the physics of optics in the pre- and post-measurement for the experimental and control group

Group (Teaching strategy)	size Of sample	Pre-test		Post-test	
		Means	Standard deviation	Means	Standard deviation
Experimental (Directed inquiry)	34	87.61	9.73	101.12	10.34
Control (Traditional method)	32	81.44	8.78	94.32	9.8

Highest Score: 125

Table (7) shows that there is a difference between the means of the experimental and control group on the pre-measurement where the experimental group was (87.61) of the total (125) degrees, and the control group was only (81.44). On the post -test, the performance of the experimental group was (101.12) and the control group was (94.32) with the difference of 6.8 degree. For the purpose of checking whether the difference between the means of the performance of the experimental group and the control group on the post- test was statistically significant at the level (α=0.05) the researchers used analysis of covariance (ANCOVA) .The following table shows the result of statistical analysis:

Table (8)
Covariance analysis (ANCOVA) of the students' attitudes toward the subject of the physics of optics i

Source of variation	sum of squares SS	Degree of freedom DF	Means of sum squares MSS	calculated value (F)	Sign. level
Pre - measurement	1776.5	1	1776.5	14.47	0.000
Group	22321.3	1	223321.3	181.77	0.000
Error	7734.3	63	122.8		
Total	31832.1	65			

***Significance level (α=0.05)**

The table (8) shows that there is a statistically significant difference at the significance level (α=0.05) between the mean scores of the students in the control and experimental groups in the post-test as the calculated F value was (181.77) and this value is statistically significant. For the purpose of verifying the validity of the null hypothesis which states that there no statistically significant difference at the level (α=0.05)in means of tenth grade students' attitudes towards the subject of physics of optics. The adjusted means were used to examine that and the following table illustrates that:

Table (9)
Adjusted means and standard errors for the attitudes of tenth grade students towards the subject of the physics of optics in the experimental and control groups

Groups	Adjusted mean	Standard error
Experimental (directed inquiry strategy)	103.75	3.02
Control (Traditional method)	95.21	3.14

The results of adjusted means for scores of the students in the experimental and control groups indicate that students' attitudes scale towards the subject of the physics of optics was in favor of the students in the experimental group as they achieved (103.75) which is higher than the scale of the control group which studied according to the traditional method which achieved (95.21), and therefore the null hypothesis which states that there is no statistically significant difference at the level ((∞= 0.05) in the attitudes tenth grade students about the subject of the physics of optics due to the strategy of teaching (the directed inquiry /traditional method) is rejected , and the alternative hypothesis which says" the strategy used influences students' attitudes towards the subject of physics", is accepted.

To find out the Effect Size and contrast ratio for the impact of the teaching strategy on the students' attitudes towards the subject of optics, the square (Eta Square) was used; and its results are shown in the following table

TABLE (10)
ETA SQUARE VALUE OF THE ATTITUDES OF TENTH GRADE STUDENTS ABOUT THE TOPIC OF OPTICS

Source of variation	sum of squares SS	$^2\eta$	Interpreted variation ratio	effect size
Covariate variable	1776.5	0.0559	5.59%	high
Teaching strategy (directed inquiry / traditional method)	22321.3	o.7012	70.11%	
Error	7734	o.2430	24.30%	
Total	31832.1			

The table shows that the effect of the teaching strategy was high with the value (o.7012) and this demonstrates that the teaching strategy caused a variation and explain the rate of (70.11%) of the total variation in the achievement of tenth grade students in the subject of optics, and this means that teaching according to the directed inquiry strategy had impact on students' attitudes towards the subject of optics, which caused significant impact in improving the level of students.

It can be attributed to the teaching strategies towards the subject of the physics of optics, and that the parameter is a critical element and key to the success of the educational process of learning in general, and that the development of scientific attitudes does not take place through a limited number of lessons, but we also need to provide multiple, diverse and ongoing experiences aiming at enhancing the desired attitudes.

The abundance of scientific activities helped a lot in the development of stimulating scientific attitudes towards the subject of physics of optics and as a result, possessing scientific ideas and skills. As the development of scientific attitudes of the students will not only be linked with what it offers from correct and comprehensive scientific information for the students, but it is associated with the use of teaching methods that require the students thinking, comparison, analysis, discovery, and communication, and the expression of ideas, and the use of sound scientific language that allows the teacher the opportunity to work on modifying the scientific students attitudes. This is why, the activities that have been designed and prepared in accordance with the directed inquiry strategy, were approved in this study.

The directed inquiry strategy also changed the role of the teacher from the traditional role to the role of strategy organizer and facilitator; where the female students gave interest to discuss and analyze ideas, and consider the views of the students by applying the activities and reflections that they had. In addition to organizing the students' thinking and directing them to evaluate ideas, compare them and take appropriate decisions, which might have contributed to the support of scientific attitudes .

Recommendations

In light of the results found in the study;

1- The researchers recommend using the directed inquiry in teaching optics as it improves their work and promotes their positive attitudes

2- The adoption of the directed inquiry strategy in training physics teachers and supervisors and in continuous learning programs.

3- The possibility of using the directed inquiry strategy in teaching other branches of physics after conducting similar studies and reaching similar results.

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