The effect of using the history of sciences on conceptual understanding and intrinsic motivation

Djanette BLIZAK

The University of UMBB, Boumerdès, ALGERIA

***Corresponding Author E-mail: bdmeriem@yahoo.fr**

Received 12 Aug., 2016
Revised 28 Jun., 2017

Contents

Abstract

This study investigates the effect of using the history of science in teaching geometrical optics on the motivation and conceptual understanding of first year university students. For this purpose, 54 students were randomly selected, then divided into two groups: the experimental group was taught by using history of science before traditional geometrical optics teaching, and the control group was taught by traditional method only. Data were collected using two instruments: Geometrical Optics Understanding Concept Test and Geometrical Optics Intrinsic Motivation Scale. The finding showed that before instruction, the students have important and prevalent misconceptions about vision, propagation of light and refraction. After teaching of geometrical optics, the study shows that using the history of science shows greater effect on intrinsic motivation and concept understanding. The results have some implications for teaching physics, especially when the traditional teaching is inevitable.

Keywords: History of Science, geometrical optics, motivation, misconception.

Introduction

In the last two decades, many researchers in physics education were interested in the concepts and students' beliefs about light because the optics field has seen a tremendous development.

Terms such as misconceptions, preconceptions, alternative frameworks, children's science, naive conceptions and so forth; are used to describe such beliefs (Blizak et al., 2009). In the present paper we prefer using the word "misconception", because the student may be judged right or wrong, although a misconception is produced when people integrate new information, learnt at school, with previously held information resulting in the new knowledge being reinterpreted to correspond with everyday experiences (Duit, 2006).

Misconceptions about light in different countries have been investigated (Galili and Hazan, 2000; Şahin, 2008; Blizak et al., 2009; Anil and Küçüközer, 2010; Blizak and Chafiqi, 2014;…). The scientists have established that students come to geometrical optics (hereafter GO) lectures with misconceptions about optical phenomena derived from prior learning and everyday experiences.

In addition, the studies of post instruction students have revealed persistence and resisted changing misconceptions even after formal learning of optics (Goldberg and McDermott, 1986). Given that these misconceptions in GO hinder true understanding of scientific concepts, researchers have to inspect a new teaching strategy. Some researchers think that the applications of Technologies of Information and Communication (TIC) (Bell and Linn, 2000) and laboratory experiments (Tiberghien, 1999) are the best way to teaching light rather than learning abstract ideas given in regular and traditional instruction. Goldberg and Bendall (1995) showed that while more time is required for the computer learning environment for teaching optics than for traditional instruction, students had a positive experience and tended to be more actively engaged in the learning process.

Other scientists have used the history and philosophy of science to help students change conceptions (Piaget and Garcia, 1989; Dedes, 2005; Kousathana et al., 2005; de Hosson and Kaminski, 2007). Hosson and Kaminski (2007) developed a teaching sequence for students in middle school. They used a fictitious dialogue about vision. From the analogy between the effects of light and pain, dialogue describes a progressive construction of the concept of light as a stimulus of sight built by Ibn Al Haytham (Kitab al Manazir). These researchers showed that this sequence, which uses the history of science (HoS), has proven successful in terms of learning and motivation. Kousathana et al. (2005) suggest the addition of HoS in instruction to prepare teachers to anticipate students' misconceptions and to motivate student to learn.

Piaget and Garcia (1989), also suggest that there is a parallel between the development of individual scientific thought and the development of scientific thought in history. In addition, Dedes (2005) has underlined the significant role of the HoS as a rich bank of ideas for the design of educational material in the case of light. It may help the students to discover the practices or the intellectual processes by virtue of which they could construct the conceptual changes. He has shown that positive results for teaching vision have clearly indicated the significant role of HoS in science teaching.

If students are not motivated in a subject, they tend not to make an effort to understand the meaning of concepts that are being taught to them (Lindahl et al., 2011). Also, Breen and Lindsay (2002) draw attention to the importance of distinguishing between general and specific motivation. It is possible that a student who is not motivated to learn physics, can be very motivated to learn GO.

In our country (Algeria), for the important number of students in class rooms, the traditional teaching strategies are employed alone for teaching OG in university. Even, these methods were not successful in conceptual change, they can not been given up and modern teaching strategies such as experiment and simulation are rarely used. Thus why, other way should be explored.

As students' intrinsic motivation plays an important role in their science learning achievement and conceptual change, the objective of this study is the use of HoS for increasing their motivation to learn OG. We show in this study that giving to the students a HoS approach, without excluding the traditional teaching, can increase students' intrinsic motivation and help them better understand the concepts of the OG.

Research questions

Even if, the literature continue to affirm that using the TICs and experiments for learning optics give an appreciable result, teaching GO with transmitting methods cannot be neglected in our university especially in biology. We have large groups with an insufficient of technological and communications means. Also, in GO courses lecturers often cover a great deal of material in a short time.

Sure the history of sciences can help our students to correct their misconceptions, but the large number of students in the first year at our university and also the short times assigned to the topic of light, obliges us to ask this question: how to use HoS to change students' conception about light refraction, propagation of light and vision?

So, infusing a historical dimension can spice up interest levels, pique attention and promote motivation. The challenge is to see how this could be done judiciously without compromising curriculum objectives (Oon and Subramaniam, 2009)

We have chosen to limit this study just for; vision, propagation of light and refraction, for the reason that the HoS is very rich with interesting examples about them. And also, these concepts are fundamental for learning GO. Refraction phenomena include many aspects of optical phenomena. Furthermore, misunderstandings and misconceptions about "propagation of light", "vision" and "light refraction" often cause difficulties for students in their examination on GO. So these basic concepts must be known very well.

Moreover, gender is a factor which is likely to affect students' performances in science education. However, in this study we have chosen not to take in consideration gender differences, for the reason that the majority of students in our population are girls. Recently, Taşlidere (2013) showed that the applications of the concept cartoon worksheet to teach GO, has no significant effect of gender.

In light of the studies and ideas outlined above, the research questions of our study are twofold:

- What is the effect of a teaching sequence using HoS approach on university students' intrinsic motivation for learning GO?

- What is the effect of a teaching sequence using HoS approach on university students' understanding of GO concepts?
- Is there any correlation between intrinsic motivation and students' understanding of GO concepts?

Based on prior theory, we expect that HoS could improve the students' motivation which could be in correlation with conceptual change.

The originality of our work comes from, to our knowledge, that no person has measured intrinsic motivation after the introduction of the HoS in the courses of GO. Also the effect of the intrinsic motivation on the conceptual understanding among university students in case of GO has not been studied before.

Theoretical framework

Misconception and Conceptual change

Most studies have shown that students at all achievement levels have misconceptions concerning vision, propagation of light and refraction (Viennot, 1996; Galili and Hazan, 2000; Mistrioti, 2003; Kaewkhong et al., 2010; Blizak et al., 2013; Uzun et al, 2013…).

Kaewkhong et al. (2010), indicates Thai students in high-school, even after instruction, had significant misconceptions about the direction of propagation of light, how light refracts at an interface, and how to determine the position of image. Viennot (1996) shows that first year university students do not understand the basic principle of the image formation. Also, concerning the formation of image of an object given by a plane diopter, only 11% (N = 30) of the university's students concerned by the study of Mistrioti (2003), have given a good answer. In our previous study (Blizak et al., 2013), we have showed that students at the university think that light needs medium to be propagate.

Shadows are formed when rays of light are stopped by objects, but students think that shadows can be conceived as an image, or as something belonging to an object (Anderson and Bach, 2005). There is a need to see light as an entity in space for being able to give an explanation of the formation of shadows (Galili and Hazan, 2000). Furthermore, students from the Science Education department did not distinguish light ray and light beam (Palacios et al., 1989). Recently, When Uzun et al. (2013) have revealed that students' misconceptions about vision remained similar from primary to university level. From Heywood (2005) study, students knew how we can see an object without a clear understanding of the process of sight. The same result has been shown by Libarkin et al. (2011) 42% of teachers believed that vision requires projection of light from the eyes (eye-centred).

While misconceptions constructed at earlier ages are so strong that they are difficult to change (Ürey and Çalık, 2008), the conceptual change is necessary. That's why many models have been proposed in literature for explaining the operation of this conceptual change.

Posner et al. (1982) proposed a model that provides an explanation for how conceptual change might occur. They affirmed that learning occurs when the student, dissatisfied with his existing conceptions, finds the new concept understandable, rational and useful.

Also Duit and Treagust (2003) proposed that in order for learning to occur, students must first critically evaluate misconceptions and revise them to be compatible with the discipline.

Strike and Posner (1982) also recognize the influence of affective aspects, motivational and social factors on the process of conceptual change. In addition, Palmer (2003) stated that motivation is an important factor in the construction of knowledge and the process of conceptual change. Pintrich et al. (1993) have declared that the model of conceptual change should envisage the influence of the student's motivation in learning processes. Conceptual change is no longer limited to conditions relating solely to the content, but must take account of motivation factors.

We are convinced of the importance of the motivation can play in conception change.

Motivation

Pintrich et al. (1993) point out that learning is not entirely a rationally directed process. They indicate that the cognitive action of the learner depends on his motivational state. Thus, it is important to know more about motivation in learning and teaching process.

In the school context, Viau (1994) states that motivation is a dynamic state that has its origins in the student perceptions of him and his environment and the incentive to choose an activity, engage and persevere in his accomplishment to achieve a goal. The self-determination theory (Deci and Ryan, 2002) also identified three forms of motivation:

- Intrinsic motivation is the most self-determined form of motivation. It is the tendency to engage in an activity for the pleasure of learning and discovering new things. Thus, a student who attends the course of GO for his pleasure and the satisfaction that learning new knowledge in this area gives him is a good example of a person motivated intrinsically;
- Extrinsic motivation is the fact of engaging in activities for purely instrumental and external reasons to the activity itself
- The amotivation is the lowest level of self-determination. A person amotivated, is neither intrinsically nor extrinsically motivated.

Given its importance, the intrinsic motivation, which is done in complete absence of external pressure, has been the subject of much research in academic learning context. There is a positive relationship between intrinsic motivation and academic achievement (Niehaus et al., 2012). Pintrich et al. (1999) also affirm that students with higher levels of intrinsic motivation adopt more elaborate metacognitive and self-regulatory strategies that facilitate conceptual change.

Vallerand and Thill (1993) suggest that students who have a greater intrinsic motivation expressed more pleasant emotions in the classroom, take advantage of fun with their school work. Fettahlioglu and Ekici (2011) studied the relationship between academic self-efficacy and motivation to learn science among future teachers. They found that there is a positive and significant relationship between self-efficacy and motivation. Lin et al. (2001) have tried to answer the question: how the extrinsic and intrinsic motivation affect learning among students taking courses in biology, English and psychology at Korean universities. They found that intrinsic motivation produces better performance than extrinsic motivation. Therefore, teachers should eliminate or minimize external pressures and develop intrinsically interesting activities.

The results of scientific studies, which we have just cited above, give us a ground to choose to study just the intrinsic motivation. It should facilitate conceptual change and increase achievement. Also, gender is not taken in consideration because there is in fact no correlation between sex and motivation to learn physics (Changeiywo et al., 2012).

History of sciences and teaching optics

History of science has been presented by a number of researchers as a useful tool in science education research, especially about research on students' misconceptions in GO topics. Some researchers argue that the initial scientific knowledge of students is similar to the scientific knowledge in the ancient world, and it is composed of observations and conclusions which were often intuitive (Kaminski, 1989). For example, Most of the student's misconceptions about vision have been founded in history. Rashed (1992) has shown to how the ideas about light and vision have been developed through a 2500 year long history. Researchers have suggested that the historical approach can help achieve a better understanding of the essence of scientific phenomena, scientific methodology and the overall scientific thought (Abd-El-Khalick and Lederman, 2000; Şeker, 2011). It serves the facilitation of learning science. The presentation of old scientific models, confronting them with modern styles, and possibly presenting some arguments which led to abandon the old for the new, may raise questions among students and help them to reconsider their preconceptions. Monk and Osborn (1997) also believe that when students are discovering that very respectable and intelligent people in the past, have a very similar thinking to their own, they will be in a comforting situation.

According Zemplén (2007), HoS can be incorporated into science courses to promote a better understanding and develop critical thinking skills. Moreover, Song et al. (1997) discuss the idea that the history of science is largely a process of conceptual change with which past scientists struggled for thousands of years. Discussing theories at length, including their origin, development, and replacement by other theories can help students to understand both objective and subjective aspects of the scientific process. Students are also able to appreciate how scientific knowledge is constructed when they know the evolution of ideas in the nature of light (Oon and Subramaniam, 2009)

Chi, (2005) comments that some students' misconceptions resemble to the explanations of medieval scientists. When moving from their alternative conceptions to accepted scientific concepts, students could experience a similar journey to scientists in developing their understanding of the light propagation.

Given that the students have misconceptions in optics like those encountered by scientists in the past (Viennot, 1996; Chafiqi and Blizak, 2014), many researchers are interested in the introduction of HoS approach in teaching sequences to promote conceptual change in OG (Galili and Goldberg, 1996; de Hosson and Kaminski, 2007; Mihas, 2008).

Mihas (2008) examined ways to use historical resources in the teaching of refraction. For him, the experimental procedures can be taught using Ptolemy tables and Al-Haytham methods. The law of refraction can be used as an example of the law that has been discovered but set aside. Models of atmospheric refraction given by Al-Haythan, can be used to show the fact that the refraction cannot be considered as the cause of the variation of the size of the moon.

Galili and Goldberg (1996) proposed a linear approximation similar to Kepler's approximation of the law of refraction to get a better understanding of image formation. They have found that many teachers, in service teacher training, appreciate this form of the law giving them a grasp on refraction phenomena without disrupting them with trigonometry.

De Hosson and Kaminski (2007) have integrated in a teaching–learning sequence and experimented with six pairs of students aged 12–13 a dialogue on the ways that vision operates. They have referred to the history of the optical mechanism of vision, especially to the controversy over the direction of vision and Alhazen's ideas about the situation of dazzle by light. The analysis of the teaching–learning sequence shows that this learning process offered to the students the opportunity to identify themselves with the scientists and make them become aware of their own cognitive process. Some students who have participated in this study were able to clearly analyse the elements that helped them to change their spontaneous ideas. Students may be more motivated to learn, when they realize that:

"the different laws of refraction and the fact that Ibn Sahl's law was actually Snell's law can show that science is not progressing in a straight path but there are many instances of going back" (Mihas 2008, p. 775).

As suggested by Song et al. (1997), discussing the Greek theories and the developments made by the Eastern Islamic scientists can help children to understand both objective and subjective aspects of the scientific process. Furthermore, it can be revealed to students that science is interplay of ideas and is developed by people whose ideas change over time.

The important role of HoS and motivation in teaching science has been shown not only by the scientists mentioned so far but and its positive effect on the conceptual change among students in the field of GO has also been illustrated by the significant amount of research in physics education. Moreover, Solbes and Traver (2003) showed that several groups of 15 to 17 students can greatly enhance their interest in science after work with the documents that contain many different activities that involve multiple historical aspects of science, as biographies, original documents, or videos showing the making and the growth of the main concepts in physics and chemistry. However, Vergnaud et al. (1978) note that it is unrealistic to assume that the historical presentation of knowledge could remove all obstacles teaching. It can be used in some cases, but it can also help to rise up obstacles that do not exist with another presentation.

We consider HoS as a factor of motivation, awakening of interest and curiosity for learning scientific concepts. Thus it is a way it creates a favourable environment for conceptual change and has an effect in better success.

Methodology

Participants

In this research, we adopted the experimental research design with pre-test post-test control group. The participants of this study were 54 first-year university students at the biology department of Boumerdes University. These students come from various high schools in the country, where, they have study OG. The mean age of the subjects was 19.07 years. 88.4% of them are females. This high percentage of females is fairly representative at biology department. At our university, students are randomly assigned groups in equal in number. We randomly selected one group as the experimental group (EG) and another group was assigned as the control group (CG).

Instruments

In other to achieve the objective of this study, two measuring instruments were used:

1. Geometrical Optics Understanding Concept Test (GOUCT)

   The GOUCT is a multiple choice test, which is used to identify the student misconceptions. It comprised 10 questions, which are selected and partially modified from the studies investigating students' conception about vision, propagation of light, and imagery in refraction (Guesne, 1985; Goldberg and McDermott, 1986; Blizak and al., 2009). Each question offered 5 answers. Only one of them is correct. The correct answer was given one point, while a zero point was given to the wrong answer or a blank answer. Since the test contains 10 questions, the total score will be between 10 and 0. The test items were constructed in a way that every question reflects students' misconceptions about optics concepts (see Table 1.). The content validity of the test was confirmed by three independent experts (teacher) in physics department. The internal consistency (Cronbach α) of GOUCT was 0.85.

2. **Table 1.** Questionnaire description

Question	Item	Description
-Q1	Vision	Utilised the alternative frameworks for seeing identified by Guesne (1985).
-Q2	Propagation of light in medium.	Using camera obscura (air exists inside).
-Q3	Propagation of light in vacuum.	Using camera obscura (air does not exist inside).
-Q4	Shadow	Ball between source of light and screen. The light source is very large.
-Q5	Shadow	Ball between source of light and screen. The light source is very small.
-Q6	Formation of Image by thin lens.	Image by a converged lens on a screen (half of a lens is covered).
-Q7	Formation of Image by thin lens.	Image by a converged lens on a screen (a centre of lens is covered)
-Q8	Formation of image by a plane diopter.	Looking straightly to the fish in the aquarium.
-Q9	Speed of light.	Speed of light in different mediums.
-Q10	Refraction	Using different color of light.

3. Geometrical Optics Intrinsic Motivation Scale (GOIMS)

The GOIMS which was used in the present study was developed by the authors (Chafiqi, F. & Blizak, D., 2014). It had acceptable level in the present sample; internal consistency (mean alpha value α = 0.88) and temporal stability (mean test-retest consistency r= 0.77).

The scale includes 6 items and is scored on a 5-point Liker scale ranging from 1= "Strongly Disagree" to 5= "Strongly Agree." An example of one of the intrinsic motivation scale items reads, "I have a great desire to study geometric optics". Accordingly, the total score of the GOIMS for individual participant ranged from 6 to 30.

Teaching Sequence Using History of Science (TSUHoS)

The sequence that we have elaborated has focalized specially about the eastern Islamic scientists' works in the field of the GO. We summarize the parties of HoS presented to students during this sequence in the following paragraphs.

The philosopher Abu Ysuf Yaqub ibn Is-haq al-Kindi (801-866 AD) stating that any luminous object emits rays in every direction. He believed that all objects give of rectilinear rays that act upon the human eye and that the sun's rays allow us to see. For Abu Nasr Muhammad Ibn Tarkhan ibn Awzalagh al-Farabi (870-950 AD) the sun imparts to the eye a light that illuminates it, and imparts to colors a light that illuminates them. It is not the action of vision which allows us to see, but the power of light and the sun which allows vision to occur. The eye is passive in the visual process.

The famous Abu Ali al-Hasan Ibn al-Haytham (965-1039 AD) has been the first who has differenced between physiological optics and geometrical optics (Rashed, 1992). He was opted for an experimental approach. The names of some optical components of the eye are indeed Ibn al-Haytham's appellations: cornea (قرنيـــة), retina (شـــبكية), Vitreous Humor (الســـائل الزجـــاجي) Aqueous Humor (الســـائل المـــائي). In his treatise (Khitab-al-Manazir), he explained the anatomy of eyes and defined his lens system. And he clarified many pounds about light. We summarized them in the list below (Rashed, 1992):

- the vision as the eye receives light rays;
- the eye, when looking at a strong light, feels pain and may be damaged (Ibn al-Haytham rejected the idea that the eye diffuses light);
- light propagates away from illuminated bodies in straight lines;
- in *camera obscura* the image is reverted;

- light illuminated the objects around us and the light rays reflected from the surfaces of these objects in all directions but only when a ray from each point, which perpendicularly faces the eye, that interacts with the eye to produce an image;
- the image is formed on the crystal and not at retina;
- that light must travel at a high speed;
- the light refraction is caused by the difference in speed of light propagation in various substances;
- the ray of light arriving perpendicular to the boundary between two different transparent media, was not bent;
- the magnification was due to refraction, the bending of light rays at the glass-to-air boundary and not, as thought before, to something inside the glass.

Johannes Kepler (1571–1630) has been impressed by Ibn al-Haytham's experience using corrected camera obscura (pinhole camera). However, Kepler corrected Ibn al-Haytham's theory about vision and showed that light rays were refracted through the eye's humor to focus on the retina as an inverted image.

Concerning refraction, Claude Ptolemy adopts the model of rays emerging from eyes (Euclide). He discusses some experiments to measure the effects of refraction of rays on the surface of separation between transparent materials of different densities: air / water, air / glass, glass / water. He observed that the incident beam and the refracted beam are located in a plane perpendicular to the refraction surface and the perpendicular rays to the surface are not refracted.

For René Descartes (1596 -1650) the particles of light progressively meet more resistance when passing through different media. This led him to be the first scientist to publish the law of refraction (in 1637) or formula to describe the relationship between the angle of incidence and refraction when referring to light passing through a boundary between two different media such as air and glass. But it was Snell who technically made the first innovations.

Snell and Descartes studied the refraction phenomenon and stated that the speed of light is as high as the covered medium is dense. This hypothesis was contested by Fermat. He is the first who attributed indices to the media.

Fermat (1601-1665) conducted experiments which led to a theory about refraction. This was that the propagation of light in air is greater than in water, and briefly that the ratio of the two velocities is equal to the ratio between the sides of the angles of incidence and of refraction.

Furthermore Ibn al-Haytham described quantitatively the laws of refraction in his book (Kitab al-Manathir), but he did not give the mathematical relation. According to Sabra (1981), Ibn al-Haytham’s model could have been expressed by the constancy of the velocity perpendicular to the surface and the change of the velocity parallel to the surface. If Al Haytham could express this mathematically he would have derived a sine Law. However, in 1990 Rashed discovered the manuscript written by Abu Sad al-Alla Ibn Sahl in 984 on the Burning Instruments. He demonstrated that the Arabic optics engineer Ibn Sahl interested by the problem of the anaclastic (how curved mirrors and lenses would cause all parallel light-rays striking it to refract into a single focus) has shown «geometrically " that refraction of a medium is characterized by a constant ratio. So Rashed (1992) credited Ibn Sahl with discovering the law of refraction which is usually called Snell and Descartes’ law. He also, affirmed that Ibn Sahl is the first mathematician known to have studied lenses. In his treatise Ibn Sahl considered hyperbolic plan-convex lenses and hyperbolic biconvex lenses and he describes the law of refraction with a diagram. Rashed writes that the main aim of Ibn Sahl’s work was on finding a way to construct a burning instrument.

We believe the HoS can relive the concepts and give them more importance. that`s why, we prepared a document (in PowerPoint) on geometrical optics concepts regarding vision, propagation and refraction of light between antiquity and the 17th century. We started with the ideas of the Greeks soaps in ancient times (Pythagoreans, Ptolemi, Aristotle...). Then we insisted on the work of Ibn al-Haythem regarding vision and propagation of light. In the end, we presented the law of refraction (Ibn Sahl, Snell and Descartes).

Before presenting this work to students, the opinions of three experts were considered to improve the document and make it clearer and more relevant.

The teaching sequence using history of science (TSUHoS), that we developed, has taken two hours, in an artificial class. The teacher presented to the students, the document that we prepared (projection show data), at the conference room of the Faculty. At the beginning of the sequence, the students were asked to focus on contain of lecture and take notes. At the end of the sequence, the teacher opened a debate about the content of the documentary and encouraged student-to-student discussion.

We point out that the purpose of this sequence is to motivate students to learn and to destabilize their misconceptions about vision and refraction.

Procedure

Initially, we conducted the pre-tests (GOUCT and GOIMS) to all students concerned by our research. Then we applied the TSUHoS to the experimental group only. After a week from the application of this sequence, students in both groups (experimental and control) followed the course of geometrical optics in conventional conditions using traditional teaching method (TTM). This teaching has continued for four weeks (six hours of lectures and six hours of tutorials). Then we asked the two groups to answer questions from the post-tests (GOUCT and GOIMS) in a classroom during normal academic schedule, always allowing the students enough time to fill in the instruments appropriately. Same instructors are given to both groups. The design of this study is presented in Table 2.

The tests, that we have built, were done in the language of instruction (French).

The data were compiled and analysed using the Statistical Package for the Social Science (SPSS) for Windows computer software (version 19). The results of the analysis were used to answer the research questions.

Table 2. Research Design of the Study

Groups	Pre-test	Application	Post-test
EG	GOUCT + GOIMS	TSUHoS + TTM	GOUCT + GOIMS
CG	GOUCT + GOIMS	TTM	GOUCT + GOIMS

Results

Regarding the motivation of students to learn GO, the finding of this study showed that before the intervention, students from experimental and control groups obtained almost equivalent mean scores (in the pre-test).

The data collected by the GOIMS in Table 3, indicates that in pre-test before any intervention, there were no large difference scores between students in the experimental group and the control group (M 12.61 Sd 06.79 and M 12.42 Sd 05.06).

Also, table 3 shows that the calculated value of F test (Fcacl) is smaller than a tabulated value (Ftab) with degrees of freedom of 25 (N-1=25). Therefore the two groups present a normal distribution. Since the samples arise from populations with homogeneous variances, the t-test was calculated (table 4).

Table 3. Descriptive statistics related to students` GOIMS and GOUCT scores, in the experimental and control groups

Test	Group	N	Mean	Sd	Fcalc	Ftab(25,25)
Pre- GOIMS	CG	26	12,6154	6,79457	1,34	1,98
	EG	26	12,4231	5,06101		
Post- GOIMS	CG	26	13,4231	6,95225	1,16	
	EG	26	22,1923	5,98678		
Pre- GOUCT	CG	26	1.8846	1.17735	1,34	
	EG	26	1.7692	1.58260		
Post- GOUCT	CG	26	3.0000	1.52315	1,24	
	EG	26	4.9231	1.89574		

As shown in Table 4, the independent samples t test shows that there was no significant difference in pre-GOIMS mean scores for the EG and control groups [t(50)=0.11, p=0.91]. It means that all students, participating in this study, have the same level of intrinsic motivation.

The mean score for the treatment group increased from the pre-GOIMS (M=12.42, Sd=05.06) to the post-GOIMS [M= 22.19, Sd=05.99; t(25)=6,58, p=0.000]. Although, for the control groups, the post-GOIMS mean score (M=12.61, Sd=06.79) was slightly higher than pre-GOIMS [M=13.42, Sd=06.95; t(26)=1.4, p=0.172], with no significant difference.

Table 4. The samples t test

Groups	GOIMS	t	DF	P	GOUCT	T	DF	P
EG	Pre-Test	6.58	25	0.000	Pre-Test	13.242	25	0.000

	Post-Test				Post-Test			
CG	Pre-Test	1.4	25	0.172	Pre-Test	10,973	25	0.000
	Post-Test				Post-Test			
EG CG	Pre-Test	0.11	50	0.908	Pre-Test	0.298	50	0.767
	Pre-Test				Pre-Test			
EG CG	Post-Test	4.87	50	0.000	Post-Test	4.032	50	0.000
	Post-Test				Post-Test			

Thus, after the intervention, students from the experimental group had obtained higher mean scores for GOIMS compared to the students from the control group (Table 3). The independent samples t test result as summarized in Table 4, was unable to show a significant difference between the groups in post-GOIMS.

To study conception change, we chose a quantitative approach. Based on the data obtained by the GOUCT, the students' mean and standard deviation of pretest scores for experimental and control groups were shown in Table 3. An independent sample t-test result (see Table 4.) showed that there were no significant differences between the two groups in pre-GOUCT ($t = 0.29$, $p > 0.05$). All students in both groups have almost the same number of misconceptions about vision, propagation of light and formation of the image by lens. This indicates that the groups used in the study exhibited comparable characteristics.

Also, the paired sample t tests conducted to evaluate the impact of the interventions on the students' scores in the GOUCT, were shown in Table 4. There was a statistically significant increase in test scores from pre-test (M=1.77, Sd=1.58) to post-test [M =4.92, Sd=1.89, $t(25)= 13.24$, $p =0.000$] for the experimental groups. The students' understanding concepts of GO in the control groups also showed a statistically significant increase in test scores from the pre-test (M=1.88, Sd=1.18) to the post-test [M=3.00, Sd=1.52, $t(25)=10.97$, $p<0.000$].

When the post-test means scores were compared using independent samples t test, it was found that a statistically significant difference between the experimental group (M =4.92, Sd=1.89) and control group (M = 3.00, Sd =1.52) mean scores existed in favor of the experimental group [$t(50)=4.03$, $p <0.05$].

The results from the Table 5 show that there was a slight increase in the students GO understanding in the control group, while there was a net increase in the percentage of correct answers given by students in the experimental group after the treatment. For example, in question 3 (about propagation of light in vacuum), the frequency of correct responses was increased from 15% to 42% in EG and from 15% to the 19% in CG.

Table 5. Frequency of correct responses (%) in GOUCT

	EG (*N* = 26)		CG (*N* = 26)	
	Pre-GOUCT	**Post-GOUCT**	**Pre-GOUCT**	**Post-GOUCT**
Q1	23	73	27	38
Q2	27	58	27	35
Q3	15	31	19	23
Q4	15	42	15	19
Q5	19	42	15	23
Q6	8	35	8	15
Q7	12	35	15	19
Q8	27	65	23	42
Q9	12	62	15	35
Q10	19	62	15	42

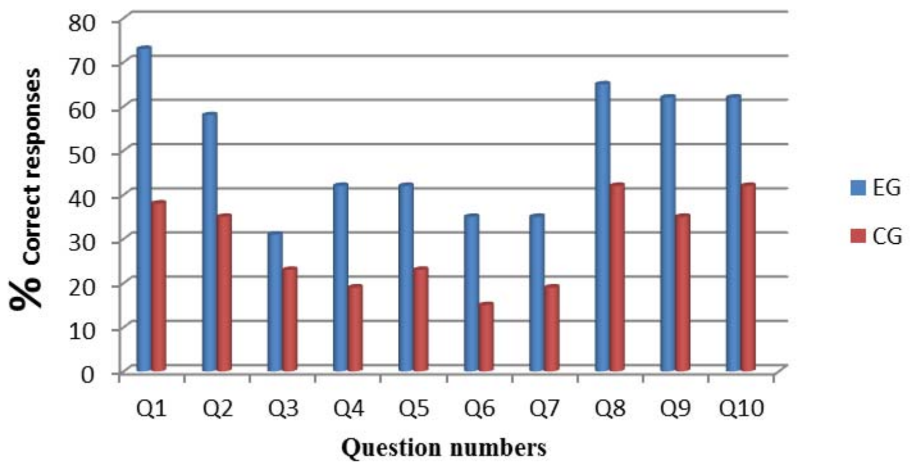

Figure 1. Comparison between post-GOUCT scores of EG and CG

The histogram, in Figure 1, clearly shows the difference between the frequency of correct responses of the experimental group and the control group post-GOUCT after treatment. More than 70% of the students in EG have a correct concept about vision, while almost 60% of students in CG still had misconception about vision, even though they attended courses on OG. It is very clear that the use of our sequence HoS, had a positive effect on understanding GO concepts and eliminated some misconceptions.

Pearson correlations were computed in order to find the relationship between students' intrinsic motivation and understanding GO concepts. The findings indicated a positive significant correlation between students' intrinsic motivation and understanding GO concepts ($r= 0.812$, $p \leq 0.01$).

Further analysis was conducted using a regression analysis incorporating students' intrinsic motivation, as predictor variable. The findings indicated an overall significant effect on students' understanding GO concepts, $F(1,50)=97.118$, $p<0.01$. This result demonstrates that the relation between dependent and independent variables are linear. In the Table 6, it is seen that intrinsic motivation predicts %66 (R2=0.660) of understanding GO concepts. Intrinsic motivation is found to be significant predictors.

Table 6. Results of the regression analysis using the post-test data

Dependent variable	Independent variable	β	Standart error β	r	R2	t	F	Sig. of F
Understanding GO concepts	Intrinsic motivation	0.812	0.021	0.812	0.660	9.855	97.118	.000

Discussion

The main purpose of this study was to explore the effects of HoS on students' understanding of GO concepts and their intrinsic motivations to learn GO. Before giving any instruction about GO, the university students in both experimental and control groups were examined in order to their intrinsic motivation and understanding GO concepts. It was found that there is no statistical difference between experimental group and control group students.

All students in EG, attended a teaching sequence using HoS in the case of GO. It was designed mainly to increase student's intrinsic motivation to learn GO in order to improve their understanding of GO concepts and reduce misconceptions as compared with what may be done in traditionally designed GO courses only. Then the GOUCT and GOIMS were administered, again, to all subjects after the treatment to know the effects of HoS on students' understanding of GO concepts and their intrinsic motivation. Inquiry EG had a significantly higher post-test mean score on the GOUCT and GOIMS than the just traditionally taught group. Following this result, the intrinsic motivation and understanding of GO concepts, for students who have undergone traditional education only, did not changed. This confirms the results obtained by many studies in sciences education, concerning the non effectiveness of the use of traditional teaching strategies for science teaching (Elcin and Sezer, 2014).

The HoS designed GO instruction may cause to difference in intrinsic motivation and conceptual change of students at university.

The obviously high positive correlation of 0.81 is very indicative of a real relationship between students' intrinsic motivation and understanding of GO concepts. Students with high intrinsic motivation towards learning GO, generally, did well on the GOUCT and students with low motivation generally did poorly on the same test. In other words, this relationship suggests that if the motivation is low, students' understanding of GO concept will be low, and if motivation is high, students' understanding of GO concept will be correspondingly high as consistent with the study (Noels et al., 1999).

The enhancing intrinsic motivation allows the students to gain satisfaction in completing the learning task successfully (Deci and Ryan, 2002). Also, Hancock (2004) asserts that a motivated learner gives good results.

Conceptual change was noted. Many misconceptions appeared to be completely eliminated. For example, after teaching the GO, 23% of the CG students have correctly answered question 3 of GOUCT, while they were 19% in the pre-test to answer correctly the question (just 4% of students have completely eliminated their misconception). Although, 16% students of the EG had moved from a belief that "light do not propagate in vacuum or propagate just in horizontal direction when air does not exist" to a belief that "in vacuum, light propagate in all direction" This type of conceptual change was classified, by Palmer (2003) as radical change because it involved a replacement or reorganizing of a central concept (Posner and al., 1982).

Also, we noted that almost 50% of students in EG have corrected their misconceptions about vision. This result is in accordance with the results of the study conducted by de Hosson and Kaminski (2007). They showed that the historical account of vision is probably the best way to confront students' ideas and facilitate conceptual change.

According Zemplén (2007), the development of understanding of the concept among the scientists could have an impact on conceptual change and motivation among students.

So, as Oon and Subramaniam (2009) confirmed; infusing a historical dimension can spice up interest levels, pique attention and promote motivation. The HoS may be a useful and enriching expansion of the established ways of physics education.

Conclusion

This work is important because most studies have focused on geometrical optics at the elementary and the secondary school indeed; it is seldom that the teaching of GO for university students in Algeria has been studied. Moreover, what makes our study more interesting and practical is the fact that we kept the traditional teaching methods. Despite the unsatisfactory results of these methods in the learning of sciences, higher education in our country cannot ignore them for the reason of the increase of the number of first-year university students and lack of resources to use more modern technology like simulation and experiences. Also, there is need to motivate students in biology department towards studying GO or physics so that the learners can acquire knowledge and concepts that will be relevant in their future studies.

As a conclusion of this research paper, the following items summarize the findings after comparing the results of the experimental group and the control group at the pre-test and the post-test:

- intrinsic motivation has increased among students in the experimental group;

- intrinsic motivation for learning the OG, among students in control group, has not changed;
- high positive correlation (0.81) between the intrinsic motivation and understanding of GO concepts;
- many misconceptions appeared to be completely eliminated in a substantial number of students in the experimental group and among fewer students in control group.

From these findings, we can response to our researches questions:

- teaching sequence using HoS approach has a positive effect on university students' intrinsic motivation for learning GO;
- teaching sequence using HoS approach help university students' to understand concepts of GO;
- it exists a positive correlation between intrinsic motivation and students' understanding of GO concepts.

Thereby we can conclude that the use of HoS helped the students to fully benefit from the GO courses. We think that when students notice the importance of certain concepts (eg: refraction, vision), it could urge them to be more interested in the learning of these concepts. In other words, their intrinsic motivation increases. When the students discover that scientists, very famous in their times, had similar misconceptions and that the concepts are provisional and evolutionary, it could cause them to have an intrinsic motivation and a self-determination to continue their learning. This can facilitate the conceptual change and the understanding concepts.

Following this research, several perspectives are possible to develop teaching strategies integrating the history of science in order to improve student motivation or a favourable conceptual change.

However, because of the small number of students participating in this study, these results will need to be re-confirmed on a larger number of individuals. In order to more clarify the students' misconceptions on OG, a qualitative study is recommended. Also, to ensure the effective role played by HoS, the study should be expanded to include other specialties such as: electricity, chemistry….. In addition, the effect of the increase in intrinsic motivation on student achievement in the case of geometrical optics could be the subject of a future study.

References

Abd-El-Khalick, F. & Lederman, N. G. (2000). The influence of history of science courses on students' views of nature of science. *Journal of Research in Science Teaching, 37*, 1057–1095.

Andersson, B. & Bach, F. (2005). On designing and evaluating teaching se*quences taking geometrical optics as an example.* Science Education, 89(2), 196-218.

Anıl, Ö. & Küçüközer, H. (2010). Ortaöğretim 9. sınıf öğrencilerinin düzlem ayna konusunda sahip oldukları ön bilgi ve kavram yanılgılarının belirlenmesi.*Türk Fen Eğitimi Dergisi, 7*(3), 104-122.

Bell, P. & Linn, M. (2000). Scientific arguments as learning artifacts: Designing for learning from the web with KIE.*International Journal of Science Education, 22*(8), 797-817

Blizak, D., Chafiqi, F. & Kendil, D. (2009). Students misconceptions about light in Algeria. In Education and Training in Optics and Photonics (p. EMA5). Optical Society of America.

Blizak, D., Chafiqi, F. & Kendil, D. (2013). What thinks the university's students about propagation of light in the vacuum?. *European Scientific Journal, 9*(24).

Blizak, D. & Chafiqi, F. (2014). Determination of University Students' Misconceptions about Light Using Concept Maps. *Procedia-Social and Behavioral Sciences, 152*, 582-589.

Breen, R. & Lindsay, R. (2002). Different disciplines require different motivations for student success. *Research in Higher Education, 43*(6), 693-725.

Chafiqi, F. & Blizak, D. (2014). L'effet de l'utilisation de l'histoire des sciences dans enseignement de l'optique géométrique sur la motivation d'apprentissage. Analele Ştiinţifice ale Universităţii" Alexandru Ioan Cuza" din Iaşi. *Ştiinţe ale Educatiei*, (XVIII), 43-68.

Changeiywo, J. M., P. W. Wambugu, P. W. & Wachanga, S. W. (2012). Investigations of students' motivation towards learning secondary school physics through mastery learning approach. *International Journal of Science and Mathematics Education, 9*(6), 1333-1350.

Chi, M. T. (2005). Commonsense conceptions of emergent processes: Why some misconceptions are robust. *The Iournal of the Learning Sciences, 14*(2), 161-199.

Deci, E. L. & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.

Dedes, C. (2005). The mechanism of vision: Conceptual similarities between historical models and children's representations. *Science & Education, 14*(7-8), 699-712.

De Hosson, C. & Kaminski, W. (2007). Historical controversy as an educational tool: evaluating elements of a teaching–learning sequence conducted with the text "dialogue on the ways that vision operates". *International Journal of Science Education, 29*(5), 617-642.

Duit, R. & Treagust, D. F. (2003). Conceptual change: a powerful framework for improving science teaching and learning. *International Journal of Science Education, 25*(6), 671-688.

Duit, R. (2006). Bibliography. Students' alternative frameworks and science education *STCSE.* (http://www.ipn.uni-kiel.de/aktuell/stcse/stcse.html).

Elcin, M. & Sezer, B. (2014). An Exploratory Comparison of Traditional Classroom Instruction and Anchored Instruction with Secondary School Students: Turkish Experience. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(6), 523-530.

Fettahlioglu, P. & Ekici, G. (2011). Affect of teacher candidates' academic self-efficacy beliefs on their motivations towards sciences. *Procedia Social and Behavioral Sciences, 15,* 2808–2812.

Galili, I. & Hazan, A. (2000). Learners' knowledge in optics: interpretation, structure and analysis. *International Journal of Science Education, 22*(1), 57-88.

Goldberg, F. M. & Bendall, S. (1995). Making the invisible visible: A teaching/learning environment that builds on a new view of the physics learner. *American Journal of Physics, 63*(11), 978–991.

Goldberg, F. M. & McDermott, L.C. (1986). Student difficulties in understanding image formation by a plane mirror.*Phys. Teach. 24*, 472-480.

Goldberg, F. M. & Bendall, S. (1995). Intermediate States and Powerful Ideas: Learning about Image Formation.

Guesne, E. (1985). *Children's ideas in science* (pp.10-32). Philadelphia, PA: Open University Press.

Hancock, D. (2004). Cooperative learning and peer orientation effects on motivation and achievement. *The Journal of Educational Research, 97*(3), 159-168.

Heywood, D. S. (2005). Learning and Teaching About Light: Some pedagogic implications for initial teacher training.*International Journal of Science Education, 27*(12), 1447-1475.

Kaewkhong, K., Mazzolini, A., Emarat, N. & Arayathanitkul, K. (2010). Thai high-school students' misconceptions about and models of light refraction through a planar surface. *Physics Education, 45*(1), 97.

Kaminski, W. (1989). Conceptions des élèves (et autres) sur la lumière. *Bulletin de l'union des physiciens, n° 176*, 973-996.

Kousathana, M., Demerouti M. & Tsaparlis G. (2005). Instructional misconceptions in acid-base equilibria: an analysis from a history and philosophy of science perspective. *Sci. & Educ., 14*, 173-193.

Libarkin, J. C., Asghar, A., Crockett, C. & Sadler, P. (2011). Invisible misconceptions: Student understanding of ultraviolet and infrared radiation. *Astronomy Education Review, 10*(1), 010105.

Lin, Y. G., McKeachie, W. J. & Kim, Y. C. (2001). College student intrinsic and/or extrinsic motivation and learning. *Learning and Individual Differences, 13*(3), 251-258.

Lindahl, B., Rosberg, M., Ekborg, M., Ideland, M., Malmberg, C., Rehn, A. & Winberg, M. (2011). Socio-scientific issues: a way to improve students' interest and learning?. *US-China Education Review B, 1*(3), 342-347.

Martinand, J.L. (1993). Histoire et didactique de la physique et de la chimie : quelles relations? . Didaskalia, de Boeck, n°2, 89-99.

Mihas, P. (2008). Developing Ideas of Refraction, Lenses and Rainbow Through the Use of Historical Resources.*Science & Education 17*, 751–777.

Mistrioti, G. (2003). Optique géométrique et interprétation de la vision par les étudiants universitaires: un modèle d'interprétation de la vision d'une image virtuelle (Doctoral dissertation, Paris 7).

Monk, M., & Osborne, J. (1997). Placing the history and philosophy of science on the curriculum: A model for the development of pedagogy. *Science education, 81*(4), 405-424.

Niehaus, K., Rudasill, K.M. & Adelson, J. L. (2012). Self-efficacy, intrinsic motivation, and academic outcomes among Latino middle school students participating in an after-school program. *Hispanic Journal of Behavioral Sciences, 34*, 118-136.

Noels, K. A., Clément, R. & Pelletier, L. G. (1999). Perceptions of teachers' communicative style and students' intrinsic and extrinsic motivation. *The Modern Language Journal, 83*(1), 23-34.

Oon, P. T. & Subramaniam, R. (2009). The nature of light: I. A historical survey up to the pre-Planck era and implications for teaching. *Physics Education, 44*(4), 384.

Palacios, F. J. P., Cazorla, F. N. & Madrid, A. C. (1989). Misconceptions on geometric optics and their association with relevant educational variables. *International Journal of Science Education, 11*(3), 273-286.

Palmer, D. H. (2003). Investigating the relationship between refutational text and conceptual change. *Science Education, 87*(5), 663-684.

Piaget, J. & Garcia, R. (1989). *Psychogenesis and the history of science*. Columbia University Press.

Pintrich, P. A., Marx, R. W. & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*, 167-199.

Posner, G. J., Strike, K. A., Hewson, P. W. & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science education, 66*(2), 211-227.

Rashed, R. 1992. Optique et Mathématiques: Recherches sur L'Histoire de la pensee Scientifique En Arabe (collected works), Variorum.

Sabra, A. I. (1981). *Theories of light, from Descartes to Newton*. CUP Archive.

Şahin, Ç., Ipek, H. & Ayas, A. (2008). Students' understanding of light concepts primary school: A cross-age study.*Asia-Pacific Forum on Science learning and* teaching, 9(1), Article 7.

Şeker, H. (2011). A Facilitator Model for the Use of History of Science in Science Teaching. *Journal of Turkish Science Education (TUSED), 8*(3), 59-68.

Solbes, J. & Traver, M. (2003). *Against a Negative Image of Science: History of Science and the Teaching of Physics and Chemistry, Science & Education 12*, 703–717.

Song, J., Cho, S. K. & Chung, B. H. (1997). Exploring the parallelism between change in students' conceptions and historical change in the concept of inertia. *Research in Science Education, 27*(1), 87-100.

Strike, K.A. & Posner, G.J. (1982). Conceptual change and science teaching. *European Journal of Science Education, 4*, 231-240.

Taşlidere, E. (2013). The Effect of Concept Cartoon Worksheets on Students' Conceptual Understandings of Geometrical Optics Kavram Karikatürleri ile Zenginleştirilmiş Çalışma Yapraklarının Öğrencilerin Geometrik Optik Konusundaki Kavramsal Anlamalarına Etkisi. Education, 38(167).

Tiberghien, A. (1999). Labwork activity and learning physics-an approach based on modeling. *Practical work in science education*, 176-194.

Ürey, M. & Çalık, M. (2008). Combining different conceptual change methods within 5e model: a sample teaching design of 'cell'concept and its organelles. *Asia-Pacific Forum on Science Learning and Teaching, 9*(2), Article 12.

Uzun, S., Alev, N. & Karal, I. S. (2013). A Cross-Age Study of an Understanding of Light and Sight Concepts in Physics. *Science Education International, 24*(2), 129-149.

Vallerand, R.J. & Thill, Edgar E. (1993). *Introduction à la psychologie de la motivation*. Laval (Quebec) : Editions Etudes Vivantes, 674.

Vergnaud, G., Halbwachs, F. & Rouchier, A. (1978). *Structure de la matière enseignée, histoire des sciences et développement conceptuel chez l'élève*. Revue française de pédagogie, 7-15.

Viau, R. (1994). *La motivation en contexte scolaire.* Saint-Laurent, QC: Éditions Du

Renouveau Pédagogique.

Viennot, L. (1996). *Raisonner en physique*. De Boeck.

Zemplén, G. Á. (2007). Conflicting agendas: Critical thinking versus science education in the international baccalaureate theory of knowledge course. *Science & Education, 16*(2), 167-196.