ESTABLISHMENT FOR MISCONCEPTIONS THAT SCIENCE TEACHER CANDIDATES HAVE ABOUT GEOMETRIC OPTICS

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ABSTRACT

This study is planned to establish the misunderstandings that science teacher students have about optics. Study data was obtained from 35 sophomore students of Agri Education Faculty, Science Teaching Program during the time period of 2004-2005 fall semester, by applying a 3-tired multiple choice test, which contained 19 question articles and making interviews with ten different students. The result of the tests and interviews with students (teacher candidates) shows that students have misunderstandings about "light propagation", "light reflection," and "light refraction". Student's understanding levels on these subjects are 24.3%, 58% and 25% respectively. Some misunderstandings about light refraction are; "Special beams have drawn as they are reflected from the thin and thick edged lenses" and "Speed of light is constant and has the same value in all mediums". Some misunderstandings about reflection are; "About the formation of an object's view at plane mirror, the changes of level and the place of source of the light that illuminates the object and changes of the level and place of observer change the view that appears in the mirror" and "Special beams don't reflect but refract and pass through the mirror". In addition, to know that teacher candidate students have a low level of understanding about 'light propagation', 'light reflection' and 'light refraction.' In order to establish these misconceptions and fix them in relative programs, representative classes are needed and this is important for science education.

Keywords: *Science Education, Optics, Misconceptions, Teacher Candidates, Physics Education*

INTRODUCTION

In the recent time period, which the importance of science education is increasing, learning the basic science concepts will help students to be able to learn advanced science subjects easier. Instead of teaching subjects, Science Education seems to be tending to teach concepts in recent years. Therefore, as the other countries in the world, there are many studies continuing about concepts in our country too. In order to make sure that students have an understanding level for concepts, to establish the misconceptions and to fix the misconceptions, these studies are concentrate on developing materials and researches on teaching techniques to teach the concepts. Researchers reveal that some time, students have different understandings and statements from scientists have about concepts (Osborne 1982, Palmer 2001). From Scientific Environments, unaccepted Student Statements are generally, "Misconceptions", "Preconceptions", "Alternative Framework", "Common sense concepts", or "Spontaneous Knowledge" (Ayas, Ozmen, Costu, 2002). These Misconceptions full thoughts keep the person from understanding subjects and develop the concepts in their mind.

There are studies in Physics Science that are to establish student misunderstandings and

understanding levels. Among these, Light and Light reflection, Light Refraction and the ones about colors are reserving important places [Kaya and Buyukkasap, 2004, Epik and dig. 2001, Buyukkasap and Samanci, 1988; Yildiz 2000; Feher and Meyer 1992; Galili and dig, 1991, Anderson and Karrquist, 1983]. Kaya and Buyukkasap have established student's understandings levels and misunderstandings about Light and atom (Kaya and Buyukkasap, 2004). As outcome of this research, we have established that student's understanding levels on Light and Atom are 26%, and 84% and misunderstandings on the Light and Atom are 34% and 6% respectively. Misunderstandings about Light were found as "Light is the Substance that illuminate the surface it attains", "Light is a group of lines that comes from a certain source and goes towards eternity" and it's relation with Atom is found as "Atom is the smallest indivisible piece of substance". Guesne and Dig (1985), Ramadas and Direves (1989) and Yildiz (2000) have worked on the definition and structure of Light. The misconceptions about the definition of Light that Yildiz has designated in his study with sixth grate (elementary school) students were found, as "Light is an illuminator substance", "Light is an effect that supplies to see" and "Light is as same as daylight". Guesne and his friends have established that 13-14 year old students have been considering the light as existed. Ramadas and Direves made students to make definition of "light". Lots of student said that light was a group of long, slim and bright lines. Because of the fact that the distance that light takes directly is invisible, it is difficult for students to make definition of existence of the light.

As indicated in the literature, learners have widespread misconceptions. In order to cease them, first of all, teachers and pre-service teachers have to gain knowledge of the misconceptions. Therefore, it is very significant to establish these misconceptions on the topic. As a result, in this study it has been planned to establish that what misconceptions the pre-service teachers have about light.

Misunderstandings and lack of knowledge of 'Light Concept', 'Light Reflection' and 'Light Refraction' often cause difficulties for Candidate Teachers in their future jobs. Thus, on behalf of Science Education, these basic concepts have to be known as well and the misunderstandings about Light Reflection and Light Refraction must be established and removed. For this reason, research question of the study has designated, as "Do candidate teachers have a good enough understanding level on geometric optics?" In the process of solving this problem, sub-problems below will be solved.

Candidate Science Teacher's

1. Understanding levels on Light Propagation
2. Understanding levels on Light Reflection
3. Understanding levels on Light Refraction
4. What kind of misunderstandings they have.

METHOD

The study aims to determine the conceptions and misconceptions of prospective science teachers about refraction and reflection, In addition, helping students acquire scientific thinking skills for the subjects of refraction and reflection, ensuring that they thoroughly learn the concepts they are supposed to know, helping them establish connections between the basic concepts they know and the phenomena they encounter in daily life, keep them updated about the latest developments in technology and guiding them to science and optical technology, the study is intended to contribute in their education.

The data was obtained from 70 sophomore students, whom are attained from 90 students arbitrarily, of Agri Education Faculty, Science Teaching Program during the time period of fall semester in 2004-2005.

Study data has obtained by applying a 3-tired test, which contained 19 question articles and semi-structured interviews with ten of the sample students.

At first progress of the 3-tired test, questions were asked as written, at the second progress of the test, questions were asked on a diagram and at the third progress of the 3-tired test, and questions were prepared to make sure of the answers that were given to the first and second progresses. The reason of making three-progressed test was to increase the confidence of data. To prepare the questions for this test, resources that have been applied are; I- The test that was used by Chen and his Friends (2002) to high school students in Taiwan that was suppose to determine

students' misconceptions about images at plane mirror, II- The test that was used by Yildiz to the sixth grade (elementary school) students to establish misconceptions about 'The Light Unit' and III- Experts opinions. Researchers prepared 30 multiple-choice questions on Light propagation, Light reflection, and Light Refraction to establish student's misunderstandings about subject. In order to examine the validity of these questions, five experts in Science field, which are in charge at the Agri Education Faculty and Kazim Karabekir Education Faculty, examined the questions by analyzing from the sight of validity, fixed the needs and brought the number of questions down to 22. The test was prepared as multiple-choice test and last choice of questions of the multiple choices test is prepared as "If you think that none of these choices is right, write your own answer or illustrate in a diagram". Only one article of the answer choices was prepared as correct and the others are to cause misconceptions. First practice of this test was applied to 32 first grade students of Agri Education Faculty. After first practice of the test, three unclear questions were taken out of the test because of not understandable. After unclear questions were taken out of the test, the other questions were reviewed and then the validity of the test 'α-coefficient number' was found 0.69.

In order to support the test results and establish the students' misconceptions, there are interviews composed of ten questions applied to the students. The purpose of semi-structured interviews was to make the person more comfortable and give them more room for their statements about topic and to let them be able to explain their answers easier (Karasar 1994). Thus, it was possible to expose Candidate Teachers misunderstandings. Interview data were recorded in writing method.

During data analyzes, every correct answer to the questions in the test was taken as understanding and incorrect answers were taken as misunderstandings. Frequencies and percents of correct and incorrect answers have been calculated. The discussion on how to analyze data is continuing between educators. "It is needed to establish the same and different thoughts of students that they had about topic and its details, than compare the results," says Yin. To reflect the real thoughts of students, the sentences that students have said during interviews must be taken directly and unchanged (Yin, 1994). We have represented interview's data at the question-answer form. Data analyses are made in two different ways. Original and individual thoughts are taken directly just as Yin says, but same and different thoughts from more than one person are analyzed as taking frequency and putting into percentage.

FINDINGS

In order to establish understanding levels and concept misconceptions about 'optic', data gathered and analyzed with help of basic analysis methods. Below are two main titles that research findings are based on. These two titles are given as "The Findings Obtained From Test" and "The Findings Obtained From Interviews"

Test Results

As obtained from the test, frequency and percentages of correct answers for 'Light Propagation', 'Light Reflection', and 'Light Refraction' are given on tables 1, 2 and 3.

Frequency and percentage of the test

Table 1: The Light Reflection and Inventions obtained from images of Light Reflection

	Comprehension (Understanding)		Misunderstanding		Sureness	
Question	F	%	F	%	F	%
1	7	20.0	28	80.0	31	88.6
2	18	51.4	17	48.6	26	74.3
3	9	25.7	26	74.2	27	77.1
4	14	40.0	21	60.0	26	74.3
5	17	48.5	18	51.5	25	71.4
6	27	77.1	8	22.9	33	94.3
7	25	71.4	10	28.6	34	97.4
8	27	77.1	8	22.9	31	88.6
9	23	65.7	12	34.3	31	88.6
10	27	77.1	8	22.9	29	82.9
11	20	57.1	15	42.9	27	77.1
15	30	85.7	5	14.3	31	88.6

Table 1 gives us an idea on that students have 58% average level of understanding on the subject 'Light Reflection'. The findings indicate that their understanding level of light reflection 58% is a quite low.

Misconceptions about light Reflection: In order to see an object from plane mirror in a dark room, the mirror needs to be illuminated (28.6%) while both mirror and object need to be illuminated (51.4%). The image of an object in the mirror is on the extension of observer's glance direction (20.0%). The image of an object in the mirror is always faced to the observer (22.9%). If light bulb is put to a higher level, the image of object will also appear at a higher level (11.7%). When it is put to a higher level, the image of object will appear at the lower level (57.1%). If the observer gets far from the mirror, the image of object will get far from the mirror too (31.4%). If the observer gets far from the mirror, the image of object will get closer to the mirror (20.0%). Black object is invisible from the mirror (17.1%). The image lines that come from observer reflect from the mirror and than effect the black ball (28.6%). A beam that comes from a light bulb and goes to concave mirror in any direction gets refracted and continues on its way (17.1%). A beam that comes from a light source and goes to convex mirror in any direction reflect as to pass through the focal point that is behind the mirror (14.3%).

As we can see, students have many misconceptions about light reflection. It also appears at the 3rd progress that the participants have confidence for their answers to the 1st and 2nd progress (average 79.32%).

Table 2: The Light Refraction and findings obtained from the images that have occurred by Light Refraction

	Comprehension (Understanding)		Misunderstanding		Sureness	
Question	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
14	19	54.3	16	45.7	27	77.1
16	12	34.2	23	65.8	30	85.7
17	9	25.7	26	74.2	28	80.0
18	28	80.0	7	20.0	33	94.3
19	22	62.8	13	37.2	30	85.7

Students' average understanding levels are appearing as 25% from the data on table 2. As seen from the table the students' understanding level of light refraction is quite low.

Student misunderstandings that are obtained about light refraction: An observer that looks straight to the aquarium sees the fish farther (5.7%). An observer that looks straight to the fish that is in the aquarium sees the fish at the same position (5.7%). A beam that comes from a light source and goes to thin edged lens in any direction gets reflect and continues on its way (37.1%)

As we can see, students have some misconceptions about light refraction. It also appears at the 3rd progress that the participants in a great ratio have confidence for their answers to the 1st and 2nd progress (average 80.95%).

Table 3: The findings that are obtained from 'Light Propagation' questions.

	Comprehension (Understanding)		Misunderstanding		Sureness	
Question	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
12	1	2.9	26	74.3	20	62.5
13	16	45.7	19	54.3	25	71.4

Students understanding levels about Light Propagation are appearing as average 24.3% from the data on table 3. It is seen that the student understanding level of light propagation is very low. Every article of the question (12) about Light propagation is about; speed of Light propagation, the changes on Light when it changes the medium and it is waves, Light Frequency, and Light Intensity.

Student understandings that are obtained about light propagation: while beams are passing through a medium from one another, wavelength does not change (14.3%). While beams are passing through an medium from one another, its speed doesn't change (54.3%). While beams are passing through an environment from one another, its intensity doesn't change (5.7%). When Light enters into a medium, its frequency changes (73%). If a light wave passes through the air before a glass object then through the glass object, into the air behind the glass object, the speed of light wave increases suddenly but it occurs lower than 3 x 108 m/s (22.9%). If a light wave passing through the air enters the glass object and then exits to the air again the light wave goes forward with the speed that it has from the glass object. (14.3%). If a light wave passing through the air enters the glass object and then exits to the air again, the light speed reduces (8.6%). There are important misunderstandings about light propagation as it appears. At the 3rd

progress students (participants) have confidence for their answers to the 1st and 2nd progress (average 66.95%).

The Findings Obtained From Interview

The findings that are obtained from the interviews are given below.

1. What kind of changes occur with the speed of light if the light enters to denser medium from the air that has diffraction index 1 and repasts to the air?

Two students: "Its speed reduces, after it gets out of the medium no changes occurs with its speed".

Three students: "Its speed increases suddenly, but it gets a lover speed from the speed it has in the air".

One student: "its speed gets lower than it is in the air; after it repasts to air its speed reduces again".

Other students: "its speed reduces in the denser medium, after it gets in the air; it gets its speed as before". 40% of students have answered this question correct. Many of students have misconceptions about light speed when it changes its medium.

2. When light enters to different medium. Which properties of light changes?

When light enters to a different medium:

>Seven students: "Wave length does not change". Three students: "Wave length changes".

>Five students: "Light speed changes". Five students: "Light speed doesn't change

>Nine students: "Light frequency changes". One student: "Light frequency doesn't change".

>Two students: "Light intensity doesn't change". Eight students: "Light intensity changes".

Students have many important misconceptions about light propagation in different medium.

3. If a pencil is put in front of a mirror in a dark room, to see the image of the pencil in the mirror should the flashlight be aimed at mirror or pencil or aligned parallel to the mirror? Why?

Three students said "Plane mirror needs to be illuminated by applying lantern into it" three different students said "both mirror and object need to be illuminated" and last four students said, "Only object needs to be illuminated".

4. Does an Image of a pencil in front of a mirror appear bigger when you look at the pencil from far distance or from a near distance? Why?

Seven students said, "When observer gets far from the mirror, the image of pencil appears smaller", two students said, "When observer gets far from the mirror, the image of pencil appears bigger" and one student said, "the appearance wont change its size". Many students have thoughts that object has its image by the beams that are going from eyes.

5. Does an Image of a pencil in front of a mirror slide down when you look at it from above or from down? Why?

Seven students said, "When you look at the pencil from above its image gets smaller", three students said, "Its image does not chance". It seems to be that many students have the same misconception that they had from the question before.

6. In a dark room, does the image of a pencil in front of a mirror get smaller if the lamp is raised up or become distant? Why?

Six student said "When the light source is risen up, the image of the object becomes smaller" while three of them said, "When the light source is pulled up, the image of object gets bigger". Lastly, one said, "image does not change". They all still have the same misconception from two previous questions.

7. Draw the special rays on the thick lenses and the ray that comes from any direction to it.

Two students said, "Rays will reflect back from the lens", five students said, "rays will have a straight direction" and none of the students knew what direction will rays have after they passed through the lens. The data prove that

20% of students think of lenses as reflectors, and they have not understood the Light Refraction subject, but have memorized the special rays only. Half of the students have understood the matter.

8. Draw the special rays on the convex mirror and the ray that comes from any direction to it.

Two students have described the special rays correct but these students could not state the way of the rays that come into convex mirror in any direction. Other students have described the way of special rays and the way that come into the convex mirror in any direction. It can be said that most of the students has understood the reflection of special rays from a convex mirror.

9. How does the image of an object in a denser medium change according to their place as an observer looks it from air.

Looking from an obvious angle through denser and transparent medium, "The image will get farter," said two students, and the other students said "The image of the object will get closer while looking at it from an obvious angle". "If you look through the object in the transparent medium directly, the image will be in its real position" said two students, but the others said the image will get closer. Most of students have understood light refraction and the images occur after the refraction but some of them still have misconceptions about refracted rays and the changes when they are in different mediums.

10. Do black colored objects appear in the mirror? Explain the reason?

Four students: "The reason black object has an image in the mirror is that black object scatters the light rays". One student: "The light rays that come from observer's eyes reflect from the mirror and illuminate the black object". One student: "because of black object absorbs the light, black object does not appear in the mirror". Other students said that black object appears in the mirror but they could not state the reason for that. As we can see most of students don't have the knowledge of black object that it can spread light too.

DISCUSSION AND SUGGESTIONS

In order to establish the misconceptions about optics, this study has determined that students from Science Education department have low understanding abilities and many misconceptions about Light propagation, Light reflection, and Light Refraction.

According to test results: student understandings about light reflection established as 58% (Table 1). Students understanding levels on light reflection are low. Main misconceptions that candidate teachers have about light reflection; "In order to see the object in the plane mirror, mirror has to be illuminated", "In order to see the object through the mirror in a dark room, both object and mirror need to be illuminated", "If the light source that is used to make image appear gets moved, the size of image of object in the mirror will get effected by this movement", "If observer moves, the image that has occurred in the mirror will move and its length will get longer", "The beams that are sent to the mound-mirror and hole-mirror get refracted and pass behind the mirror". There are misconceptions established, as black object doesn't appear in the mirror. These misconceptions support findings obtained from interview. There are different investigators have established similar misconceptions too (Chen and His Friends, 2002). We think the reasons for these misconceptions to occur with students are because students have the thought of an object for in order to appear in the mirror, light to illuminate the object has to come from the mirror and also when teachers make drawings about image occurring, teachers don't explain the light and observer that is in the environment.

Student understandings on Light Refraction established as 25% (Table 2). Students have very low understanding levels on refraction. Student's misconceptions about Light Refraction have been established. These are; "If you look at the object in a thick environment from a less thick environment, image of object will appear farter", a light beam that comes to the thin edged lens from any direction, gets reflected from thin edged lens than continue its way". The findings obtained from interviews show that very a few students have these misconceptions.

Student understanding levels on light spread have established as 24.3% (Table 3). Student understanding levels on light spread are very low. The misconceptions that are obtained from the questions that were asked about Light Spread: "Light refraction degree is not depended on light-speed-degree factor when light is spreading at different environments", "While the light is spreading in different environment, its speed, strength and wave-length doesn't change" and "While light is passing through clear environment from another clear environment, its frequency changes". The findings that are obtained from interviews support this result.

Student's low understanding levels on optics and reasons of their misconceptions about this subject are thought as insufficient knowledge from high school, the OSS (student selecting examination) as an obstacle for school

lessons to be studied and lacking laboratory activities. In the research that Kaya and Buyukkasap have done on Light and Atom, they found elementary school, middle school and high school teachers and the materials they have been using for optics as reasons of students misunderstandings (Kaya and Buyukkasap 2004). As other reasons for our students misunderstandings, we think that is because of most of them had studied their middle and high schools at rural areas and also they had been taught science classes with the teachers whose field is not science.

Lecturers and teachers should explain the light that comes to the object and state the observer in the environment while they are explaining reflection subject and making drawings about image occurring.

The futures science teachers have to comprehend these concepts very well. The misunderstandings that teachers have will cause students to misunderstand same subject, which is an understatement. Misunderstandings that teachers have are reported in literature (Goodwin, 2000). Therefore, establishing misconceptions and misunderstandings on these subjects are needed in our faculty.

Student misunderstandings and concept misconceptions on optics are arising from middle schools and high schools teachers and materials they have used for classes. Researches and necessary precautions are needed for this subject.

Lecturers, teacher and text writer have to pay enough attention to these subjects and warn students about details, which can be misunderstood.

Also, high school and college level classes need to be taught with computer support and animation slights. Laboratory activities and developing optics materials studies needed.

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