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INTERNATIONAL CONFERENCE ON EDUCATION AND NEW LEARNING TECHNOLOGIES
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Dear EDULEARN09 attendants,

After a hard year of organisation, it is an honour to welcome you to EDULEARN09, a multicultural forum where you will be able to share your experiences in the area of education and new learning technologies.

EDULEARN09 has the pleasure to count with more than 450 delegates from 66 countries. This fact alone will ensure the richness of the contributions and will surely create a unique, varied and friendly atmosphere.

The objective of this conference is to provide you with an opportunity to exchange ideas and results, to discover new trends in education, to collaborate on technological projects, to discuss about new learning methods and many other topics that will arise from the contents of this conference.

In addition to this professional experience, Barcelona will offer you very attractive things to do during your stay. Its places of interest such as its historical centre, architecture, cultural heritage and natural surroundings will make your visit unforgettable.

Thank you very much for coming to EDULEARN09. We hope that you remember this conference for years to come as a fruitful international experience.

Thank you for attending EDULEARN09. We hope you enjoy your time with us!

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ORAL SESSIONS, 6th July 2009.

Experiences in Education: Educational Trends and Best Practice Contributions (1)
Experiences in Education: Curriculum Design and Quality Assurance
E-Learning: E-learning Projects and Experiences (1)
Emerging Technologies in Education (1)
International projects (1)
Primary/Secondary Education: Experiences and Pedagogical Innovations (1)
Experiences in Education: Educational Trends and Best Practice Contributions (2)
European Higher Education Area: The Bologna Declaration and ECTS Experiences
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Virtual Learning Environments (VLEs) & online/virtual labs
Emerging Technologies in Education (3)
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Pedagogical Innovations in Engineering Education
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Pedagogical Innovations in Education: New Learning/Teaching Models
E-Learning: E-learning Projects and Experiences (2)
E-content Management and Development
Barriers to Learning and Diversity Issues
New trends and Experiences in Engineering Education

POSTER SESSIONS, 6th July 2009.

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Poster Session 2. Experiences in Education

ORAL SESSIONS, 7th July 2009.

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Educational Software & Serious Games
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Experiences and Pedagogical Innovations in Life & Health Sciences Education (2)
Experiences in Education: Transferring Skills and Disciplines
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Pedagogical Innovations and Experiences in Foreign Language Learning / Education (3)
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E-content Management and Development
E-Learning
Educational Software & Serious Games
Emerging Technologies in Education
Experiences in Education: Enhancing Learning and the Undergraduate Experience
Experiences in Education: European Higher Education Area: The Bologna Declaration and ECTS Experience
Experiences in Education: Learning Experiences in Primary and Secondary School
Experiences in Education: Trends and Best Practice Contributions
Experiences in Research
General Issues
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Pedagogical Innovations in Education
Pedagogical Innovations in Education: Learning/Teaching Models and Methodologies
OPEN SOLUTION PROBLEMS IN THE FIELD OF OPTICAL INSTRUMENTS

Fernández¹, E., Ortuño², M., Gallego², S., Márquez², A.

1Dep. Óptica, Farmacología y Anatomía
2 Dep. Física, Ingeniería de Sistemas y Teoría de la Señal
elena.fernandez@ua.es

Abstract

This paper develops problems with generic statements for resolution by the students of the instrumental optics subject in the optics and optometry degree. Such problems are different from the typical problems because they are a generic problem, without any particular fact or event, so that students develop a theory that covers all possible cases related with the problem. Then the students will be asked to summarize the difficulties that have been found to solve it.

**Keywords** - Teaching research, Experimental science

1. INTRODUCTION:

The motivation for use this type of problems is that students begin to develop problems with real open solution which develop part or all of the theory related to a specific topic or subject. Develop this type of problems could be used in all of the topics, but in this work, the problems will be developed for the Instrumental Optics subject, which is a second year subject of the Optical and Optometry degree.

In order to expand the knowledge about the subject, the students have to do a good approach to the problem with precision and say what the beginning premises to solve the problem are. They should then make assumptions for solving the problem that covers all possible cases. They have to look for information about the subject, develop strategies for the resolution and, finally, check that the results are consistent with the assumptions made [1-5].

In traditional classes professors explain to their students specific problems that have a particular solution with detail, explaining each step that must be followed to resolve the problem. In this way professors remove all kinds of motivation and interest to the student to solve the problems alone.

When a scientist research a specific problem is because he need to find its solution, a solution that initially is unknown. And in order to find the solution to the problem, the researcher has to follow a series of steps listed below:

- He has to define the problem.
- He has to collect the information published in the bibliography that there were currently on that topic.
- He has to propose hypotheses about possible ways of solving the problem and use these hypotheses to find all the possible solutions.
- He has to try to simplify the problem and find borderline cases that have analytical solutions and found the solution for these borderline cases.
- He has to argue the validity of the obtained results, and then the results have to be compared with those existing in the literature.
- Moreover, he has to check that the results are consistent with the hypothesis that he have done and with the borderline cases.

Those are some of the steps that researchers use in order to study and learn about a topic. Therefore, if professors want our students learn about a topic they will have to propose to the students that follow the same steps.
Thus, this paper proposes a number of unsolved problems for students to meditate and search for information in the literature to find ways to solve them.

2. THEOTY:

The purpose of this work is to get that the students develop ways for solving problems with open solution [6]. For elaborate the problems is important that students will be able to deduct all or part of the theories that they need to learn. That is to say that the problems have to be completely general so that from them the students will describe all possible cases and borderline cases that may exist.

Therefore, the problems proposed to students have to be problems which the students does not know the solution before propose the ways to solve the problem.

Before the problems were elaborated, the professors have to make some questions to themselves:
- Is there a problem to justify the resolution of the problem? Is it justified inside the subject?
- Is given the opportunity to students to make hypotheses?
- Can the students think about a strategy for solving the problem?
- Are the students sufficiently prepared for the interpretation of the results? Do they have the opportunity to compare the results with theories that are listed in the literature and discuss possible discrepancies?

Once all these questions are clear, the problems have to be devised for answers to these questions affirmatively.

The motivation for this change in the resolution of the problems has been because the teachers of the subject realized that the students only copied into his notebook the solutions and did not know why the problem had to be solved that way. Moreover, only few students understand the true meaning of what is being done, they do not know why the teacher solves the problem just like that and not another and not even know that there are several ways to solve the same problem.

In the course of Instrumental Optics, students essentially have to distinguish between objective and subjective optical instruments studying geometric and photometric characteristics of some of the most representative instruments, for example, camera, projection systems (objective instruments) and the magnifying glass, oculars, microscope and eyeglasses (subjective instruments) [7,8].

3. METHODOLOGY

3.1 Camera and projection systems

The problems in this work have been specially designed for students learn the geometric and photometric properties of the most important optical instruments. These instruments include the camera and projection systems. For example, to understand the functioning of the camera and projection systems in optical terms, the professors propose problems as follows to the students:

1. You want to take a picture to an object. Describe under what conditions should be done it to get a good picture (assuming you want to take the picture by day or night).

   - Parameters to describe: \(N, d_C, d_i, z_1, z_2, f_{OB}, 2w, T_{exp}, S_{ASA} \ldots\)

Once the photographs are taken, you want to make a presentation with all of them, what type of projection system you use and why?

   - Say what elements do you use and the position of each of them instrument magnification and the light that arrive to the screen.

Among the parameters that describe the conditions to make a good photograph, the student has to take into account the distance that the object is photographed. They have also decided
what type of lens must be put in the camera and the focal of this lens. Moreover, they must to
decide the diaphragm number and the exposure time. Also they have taken into account if the
chosen parameters are the most suitable for photographing the entire object (they have to
calculate the field that can be seen) and also to decide the sensitivity of the film. And this study
has to be done in the case to take the photograph by day or night (depending of the light of the
object these parameters will change when the picture they take it).

With respect to the projection system, they have to decide what is the place where they want to
do the presentation, that is to say, the projection distance from the projector to the screen; and
also they have to decide what kind of elements will be used to mount the projector, so that the
projected image has the size you want and also decide the light source so that the image is
properly illuminated.

Since this problem would be the first open solution that the students will resolve in the course,
with the problem we have add some guidelines so that students have to know how to begin the
problem, and what parameters have to study.

3.2 Magnifying glass and oculars

The following instruments that the students have to learn its geometrical and photometrical
properties are the magnifying glass and oculars. With these two instruments the students begin
to learn the subjective optical instruments.

The problem we propose to students is as follows:

2. You have a message with a few letters so small and you can not read it. What would
you do to find out what it says?

♦ Indicates the focus of the lens, the diameter, position of the observer, observable
field, magnification, power splitter.

What if you were myopic or hyperopic and not find your glasses?

♦ Indicates as modifying the above parameters for the two cases.

Without glasses, you need a magnifying glass with more magnification in order to
observe the details of the note. But you do not have small focal lenses with higher
magnification. How do you solve it?

♦ Use two lenses to get more magnification.

This second problem still has some comments with which students may resolve the problem.

To solve the problem, first the students have to draw a diagram of the problem. Fig 1 shows the
basic diagram of a magnifying glass. And with the diagram they have to obtain all the
parameters that characterize it. But these parameters values depend on where they put the
object. And depending where you put the object the lens will be a magnifying glass or not. To
act as a magnifying lens, the object has to be placed at a distance less or equal than its focal
length. Moreover, the magnification in the magnifying glass depends on where the observer is
placed. Therefore, students should cover different cases:

• The object is in the object focal plane of the lens.
• The object is at a distance less than the focal length of the lens.
• The observer is placed between the image focal plane of the lens and the lens.
• The observer is placed at a distance greater than the focal length of the lens.

In all these cases the magnification of the magnifying glass is going to be affected, so the
students would have to see in what case the magnification is greater than the other cases It is
also important obtain the power splitter with the magnification of the lens as this parameter tells
us what is the minimum separation of the points could be observed.
In the second part of the problem professors asked to perform the same study as the magnifying glass in the case that the observer was myopic or hyperopic. These changes also affect the magnification and the power splitter.

And in the third part of the problem professors asked to build an ocular with two lenses. To obtain large magnifications with the magnifying glass is needed to have a small focal. However, it is difficult to manufacture lenses with small focal and without aberrations. Therefore, it is easier to couple two lenses with large focal in order to obtain an instrument with small focal.

3.3 Microscope

The next item to study is the microscope. The microscope is a subjective optical instrument that is used for observe near objects, like a magnifying glass. However, the microscope was invented because with the magnifying glass can not obtain high magnifications without decrease image quality. With a microscope magnification with several orders of magnitude higher than magnifying glass can be obtained.

The microscope is an instrument that is studied well into the course (in the 2nd semester). Therefore, when professors propose the problem is no necessary give any guide to the students to solve it. Thus, the problem would be:

3. You want to observe a bacterium. Indicate what instrument will you use to observe it with all the details (including any ridges in depth).

   ♦ In the descriptions of the instrument follow the same steps as was done with the magnifying lens.

For the study of this instrument the students have to consider the same parameters as the magnifying glass. Firstly it is very important to make a diagram of the instrument and to identify their main properties, such as where each of the lenses have to be placed (in a microscope the separation of the lenses must be greater than the sum of their focal lengths). It is also important to know where the focal planes of the lens are and where the image of the object through each of the lenses is (the image that forms the first lens of the object is in the object focal plane of the second lens, so that the final image that form the second lens is at infinity). Figure 2 represents the diagram of a microscope.
It is also important to know the resolution of the instrument in order to get the minimum detail that can be seen with him. And the students have to know too how to obtain the focus depth (this parameter says us what is the maximum thickness of the object that can be observed without the need to move the microscope) in order to know if the roughness of the object can be observed without move the microscope or not.

3.4 Eyeglasses

The final subjective optical instrument that is studied in the course of the Optical Instrumentation is the eyeglasses. For the study of this instrument the problem proposed is as follows:

4. You want to see a double star. Design the instrument that you use to do it.
   ♦ Position of the elements and characteristics of the instrument have to be given.

5. You go sailing with your boat and you see another boat in the distance. Will they be pirates? Build an instrument with which you can see if the flag is of pirates or not.
   ♦ Remember that the image has to be right when you design the instrument.

For this instrument, the first that students have to know is that the object is located at infinity, so the image formed by the first lens (objective lens) is in its image focal plane. And if the observer is emmetropic then that image is at the object focal plane of the second lens (ocular lens). Therefore, in this case the eyeglasses would be an afocal instrument (the distance between the lenses is the sum of their focal lengths). Moreover, the instrument will provide an inverted image of the object. Students also have to consider what happen when the observer is myopic or hyperopic (as was done with a magnifying glass). Fig 3 represents the diagram of an astronomical eyeglass.
4. CONCLUSION

This work proposes several open solution problems to be resolved by students of the subject of "Instrumental Optics." In this way we seek that the students are able to develop some of the necessary competencies and to solve real problems.

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References


