

***Description of Case study „The glasses as a simple optical instrument,
or from what it started ...”
– for exchange in HIPST project***

1. Title:

The glasses as a simple optical instrument or how it all started ...

Key words: teaching; history of the glasses; eye lens; focal length; focusing ability.

2. Authors and Institutions:

Janusz Kosicki, physics teacher in VIII LO in Torun, janusz_kosicki@interia.pl; collaboration with the Institute of Physics, N. Copernicus University, Dr. Józefina Turło jturlo@fizyka.umk.pl

3. Summary:

Information on the simple instrument – the glasses – is provided in secondary school both in the basic and advanced level. There is a proposition in the curriculum, to link the issues connected with the glasses to how they work for magnifier, telescope, microscope. This subject is discussed as the part of core curriculum under the general issue „The light and its role in nature”.

One of the educational aims of *Physics curriculum* is „... to notice by the student the nature and structure of physics and astronomy, their development and connection to other disciplines of science...” and „...to understand the role of physics for technics, medicine, ecology, its connection to the other human activities and social implications...”.

In this lesson’s concept the starting point is the invention of glasses. It is presented as the human’s creativity product, used to correct the visual disability. Understanding its action is based on the elementary knowledge concerning the structure of the human eye as the lens. The pictures, basic for the analysis of proper vision, contain information about eye adaptation. This concept is introduced first during biology lessons, however the physical side is simplified. The lesson proposed here is complementing and expanding that knowledge. The attention is paid, how the radius of eye lens curvature affects an eye focusing ability. The problem of selection of a corrective lens for a given visual disability level is also explained and “practiced”.

In school mission, determined by curriculum, we can read, that „physics teaching should be based on every day life issues”. Using corrective lens is common and well known to all the students. If not used by them, hyperopia may affect older members of the family. Using glasses becomes a part of everyday life.

The school should also „... implement the student for the critical usage of knowledge sources”. Providing the historical information from textbooks and comparing it to the scrap of the movie we try to persuade students to put the facts in a chronological order. We pay attention to the logic and consistency of the derived information. *Thus, we show that discovering and impementing physical laws is the part of culture and the time and place of events are not incidental.*

Solving physical problems is crucial for performing mathematical operations. These abilities are necessary, especially at advanced level.

The achievements, which are supposed to get are for example the ability to explain how the correction of vision is performed using glasses (all the students) and how to master mathematical methods for solving problems on the level enabling studies of sciences, nature or technics (advanced level).

The lesson is based on the concepts which were introduced earlier, such as optical lens, focal length, focusing ability, lens curvature, refractive index. Besides, to solve the problems, students use formulae which were already adopted: $1/f=1/x+1/y$ and $1/f=(n-1)\cdot(1/r_1+1/r_2)$. The proposed lesson contains some new elements of optics, such as focusing ability of the system of two thin lenses $D=D_1+D_2$ and the concept of „good vision distance”. We also try to develop and fix the ability to use the dependence between lens radius of curvature and its focusing ability.

Problems to solve are not exceeding the curriculum content for advanced level. They are formulated as to be linked to everyday life situations. It might contribute to enhance the interest in physics.

In curriculum we are encouraged to form „...the *understanding ... of physics ... (and) its relations to other disciplines of human activity and social implications ...*”. Introducing physics by describing the context in which the discovery was made fulfills this task perfectly.

Another school task specified in the curriculum is to pass the information integrally. Including historical elements helps to meet this postulate. There is diffusion of different sciences. It allows to create the knowledge, which is easier to acquire and more permanent, the knowledge which allows to understand the world and processes around us.

4. Description of Case study

Physical phenomena presented here, are usually detached from historical context in school textbooks. The motivating element referring to the topic is to reach the scrap of the movie „The name of the Rose” directed by J.J. Annaud (based on the novel of U. Eco) and to raise a question: „Is the story you have seen in the movie fictitious or has it historical basis?”. This question, with its simplicity, provokes to search for the clear answer. But to answer this question you need to provide some historical information. The best way to do it is a multimedia presentation. The answer to the raised question may be given. That is the end of the lesson’s introduction. At this stage students should feel intellectually kicked and motivated to further work.

The consecutive part of the lesson we start with the question about the essence of the visual disability showed in the movie excerpt. The answers are based on elementary knowledge about human eye construction and the relationship between lens curvature and its focusing ability, which has been learned before. The problem should be discussed with the students contribution based on the prepared illustrations. Depending on the students’ profile and possibilities we can also provide the problems in which we derive the eye lens focal length change due to the distance of the object we observe. Another problem for students to rise, is to search for the way to correct the visual disability we present. The supplement this part of the lesson are problems in which we select the correction lenses depending on the visual disability. The problems we solve are crucial for this part of the lesson, since they formalize the phenomena we discuss with mathematics. Lesson’s summary makes the link to the previous information in the form of the test to be completed. The test solution can be prepared as part of the presentation.

Homework deals with analyzing some historical remarks to set the visual disability they are about. Contrary to the cases that we have studied during the lesson, now we meet myopia. The work is connected with the abilities acquired by students and its aim is to fix them. Depending on the students’ commitment there is also a possibility to extend the homework by taking the pictures of objects in such a way, that the sharpness is fixed either at the closer or at the farther object.

5. Historical and philosophical background, including the Nature of Science

Historical event – discovery of the glasses and their career – is the basis for the strict physics lesson. It is worth mentioning, that this kind of approach is closer to the natural one, where reaching the physical law or invention is the integral part of this law or invention. Deviding the result from the way of approaching is not always positive for the views and objectivity. The development of science is not taking place in isolation, it is also correlated to the other human activity spheres. Thus demonstrating the path and situation in which the invention or physical law has been discovered is even more didactic.

The invention, seemingly simple, begins to spread and eventually information about the inventor Disappears. The beginning of the lesson is an attempt to find the name of the inventor, or rather the person, who had a good idea of practical solution to a simple problem.

Appearance of the glasses should also be considered as a response to a demand of a large group of People.

6. Target groups, the importance for curriculum and educational benefits

The issue has been developed for high school students in a lesson, where physics is taught at the advanced level. After minor changes to the proposed tasks it can be also implemented at the basic level. Issues traditionally discussed and practiced during the lessons are usually carried out in isolation from the historical aspect. Glasses in the "classical" approach is one of several of these optical devices. Completion of this issue in one lesson with other optical instruments, although justified in terms of "saving" the time devoted to the subject taught, would not be very beneficial for some (even most) students. Therefore, this lesson in which glasses are discussed independently from the other optical instruments, may be one of the summary lessons, extending the student skills of the geometric optics.

The combination of historical elements with physics proved to be particularly effective for those students, who treat the participation in the lessons of physics as a necessity. Interest in the lesson and the involvement of students in the learning process increased. Work at the lesson through the use of the prepared presentation ran smoothly. Presentation of selected problems related to physics in historical aspect motivated large part of students to work more actively at the lesson.

7. Activities, methods and tools of learning

The beginning of the lessons is reaching for an excerpt of the movie as a motivating mean. Lesson's subject, after seeing the film, should be formulated jointly with the students. The question is whether the fragment of the film, which presented an event where glasses are used is based on historical truth, "forces" students to engage in a lesson. But in order to properly answer this question we need, through the prepared presentation, provide some historical information. The answer to the question can be given together with the indicative date of creation of the first glasses. It is important to engage in this process as much part of the class as possible.

Further questions about the nature of foresight and the correction of this defect through the use of lenses follow. Answers are based on information obtained from biology and earlier physics and biology lessons. To make it easier to provide correct answers, previously prepared drawings were used, which set the run of light rays passing through the eye lens. It is important to note the change in the shape of the lens when approaching the observed object to the observer.

Solving tasks provide the extension of student skills. They refer to the previously discussed situation. They should be accompanied by teacher's commentary, in which the physical model will be given or pointed out and guidance to the task provided.

Summary of the lesson has the form of the test to complete. Answers to test questions can be prepared as a part of an earlier presentation.

An additional element of the lesson may be a demonstration, which is to put a transparent plastic ball on the printed paper sheet, and to observe the size of letters seen in this way. This refers to the first attempts to read using the "reading stones" (*lapides ad legendum*) in low vision. The presentation is dependent on the time available. It is proposed that students who quickly solve the problem are familiar with these stones.

Homework is based on further information from the history of myopia. It is advisable to carry out this part of the lesson in the form of a short presentation. Implementation of homework is the further usage and consolidation of skills acquired in class.

Additional homework is addressed to students involved in photography. It is proposed to make images of two objects which are set at different distances from the lens, so that one image closer to the object is "sharp" and further "fuzzy" and the second picture is the opposite. At the same time we ask the students to prepare for the next lesson the answer to the question about the mechanism of focusing the camera.

8. Difficulties in teaching and learning

With the utmost attention and care one approaches to the problems (tasks) proposed to solve. Therefore, we suggest to prepare a solution in the form of presentation. This will facilitate and shorten time-solving process. At the same time it will enable the teacher paying more attention to students having a problem with the solution.

Students preparing for final exams are not delighted with the "additional" information. They prefer only what is required for the exam without the "unnecessary" information. These students are already motivated to learn physics. Subject itself is attractive to them.

In the materials available to us we did not find information about pre-conceptions on the formation of images on the retina and the role of glasses in their development.

Classes were conducted with students, who repeatedly and at different levels of education were introduced with the mechanism of vision.

However, interviews with students (and basing of the short survey before the end of optics issues), suggest that knowledge about how the image is created in the human eye is superficial. Predominated vague views, not reflecting the ordinary substance of matter. In interviews on the glasses, students wrote that: "they improve vision, sharpen image, sharpen sight, diminish or enlarge the image". In interviews on the causes of poor vision due to the age, there we could find statements: "eyes corrupt like everything else, are less efficient, the eye is not working as it should, "any cells" responsible for visual acuity disappear". Many statements could not touch directly the mechanism of vision. Explanation were given in the language of everyday speech.

9. Teacher's pedagogical competencies

All the necessary information to carry out activities in the lesson's scenario are given in the prepared presentation and the accompanying piece of film. Problems provided require prior conversion and any changes involving the adjustment of the level of skills of the students.

Therefore carrying out a course should not be too difficult.

Test at the end of the lesson can be performed either as a joint operation with simultaneous prescription of the notes, or as a work in groups, with the correct answers, so that the student could verify previously completed sentences.

10. Documentation (evidence) of research

- Lesson's scenario: <http://hipst.fizyka.umk.pl>
- Presentation: <http://hipst.fizyka.umk.pl>
- The excerpt of the movie „The name of the Rose” by Jean-JaquesAnnaud
+(*analysis of the survey at a later date*)

11. Further professional development of users

1. Zając M., „Optyka okularowa”, Dolnośląskie Wydawnictwo Edukacyjne
2. Wróblewski A. K., „Historia fizyki”, Wydawnictwo Naukowe PWN
3. Zając M., Sarnowska-Mobrat K., „Historia optyki okularowej” [w:]
http://www.optyka.if.pwr.wroc.pl/optometria/wyklady/historia_okularow.pdf
4. Bieganowski L., Małek J., „Nowe przyczynki do historii okularów w Polsce w XVI w.”
5. Multimedia presentation: Witkowska A., „Okulary i soczewki kontaktowe”

12. Written literature resources

1. Publication: Biuletyn PSNPP (1/2009), J. Kosicki, „Okulary jako prosty przyrząd optyczny czyli od czego to się zaczęło...”, pp. 23-27
2. Talk at II National HIPST Meeting in Olsztyn, 11.09.2009.
3. Multimedia presentation at II National HIPST Meeting in Olsztyn, 11.09.2009.
4. Scenario of lesson on: „*The glasses as a simple optical instrument, or from what it started...*”