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.

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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 exhance 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 refering 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 fictious 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 intelectually 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 stricte 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_okolarow.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...*

Scenario of the lesson on:

GLASSES AS A SIMPLE OPTICAL INSTRUMENT
or from what it started ...

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Introduction

Lesson on "Glasses as a simple optical instrument" is one of the last lesson of geometrical optics. It is intended as a repetition lesson, in which messages appear extending knowledge of physics, based on a historical foundation. In the presented version is designed for classes implementing the physics of the extended course due to the complexity of some set of tasks. After the substitution of any difficult tasks, this scenario can be used in the classrooms of a general profile.

Main goals:

1. Knowing and understanding the phenomenon of light passing through the lens and the lens unit and creating a sharp image in the eye of man. Understanding the issues in the context of everyday life.
2. Critical use of various sources of information

Operational goals:

Student:

1. knows and applies the concept of the focus, the focusing ability, the lens focal length,
2. used the known knowledge of the geometrical optics on lenses to explain the principles of the human eye operation,
3. understands, based on information from the geometrical optics, what is the foresight and how to correct this defect,
4. based on the given example calculates the focusing ability of the eye and lens. Can calculate the value of focusing of the corrective lenses by solving simple tasks.

Methods:

Multimedia presentation, a heuristic talk.

Forms of work:

whole-class and individual work

Teaching resources:

video, multimedia projector.

The course of lesson

Introduction

1. The teacher informs students that the subject of the lesson will be formulated after watching the short part of the film "Name of the Rose", directed by Jean-Jaques'a Annaud based on the book of the same title (this section begins at 32:08 and the time axis shows the moment in which the brother of William of Baskerville removed reading glasses). Introducing provides information about time and place of action (the end of November 1327 year, the Benedictine abbey in northern Italy). The teacher refers to the watched passage and with the help of students title of the lesson is formulated.



Photos from the film "The Name of the Rose", directed by Jean-Jaques'a Annaud

2. The teacher draws attention to the fact that in the scene shown the glasses are already known, but excites more attention of scribes, hence the conclusion, that the invention was born recently. Question: *Does the event shown in the film is fictitious or historic reason?*

3. The teacher presents a short presentation (preferably in the form of a presentation prepared for the computer) on documented information about the creation of glasses "for reading":

a) **1289** year Di Popozo "Traite de conduite de la famille" :
"I'm so overwhelmed by age, that without the glasses known as spectacles, I could not read or write. they have recently been invented for the old people with poor eyesight".

b) **1306** year a fragment of a sermon Giordano Da Rial:
"... Not yet passed twenty years from the time when the art of making spectacles were invented, but it has enabled a good vision and is one of the most useful discovery, which the world has (...) and I myself have talked with the man that has done this."

c) **1313** year died Aleksandro della Spina in Pisa, about him was written: "... He performed glasses and tought. others. Glasses previously were done by someone else, but who' did not want to say about...".

d) **1317** year Salwino Armato degli armati; epitaph in the church in Florence:
"Here lies Salwino degli armati d'Armato of Florence, the inventor of spectacles. May God forgive his sins. He died Anno Domini 1317 ".

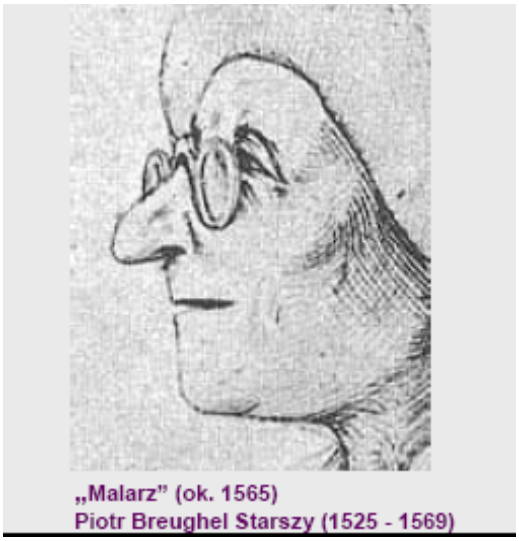
Teacher during the conversation with the students draws attention to the historical accuracy of film and determine jointly with the students the first time the creation of glasses per year around 1286.

Suplement verbal information may be presentation of selected scenes paintings, in which appear glasses (see below illustrations, which should be treated as suggestions that can be exchanged freely). It is recommended to return to the scene of the movie and pay attention to the kind of spectacle there used..

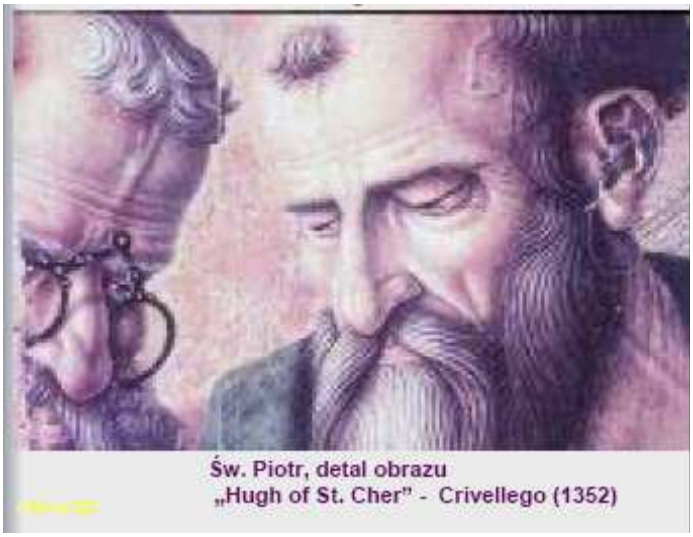
Marinus van Roymerswaele picture

Senile glasses. Portrait of cardinal Hugo de Provincja. Fresco in the Saint Nicolas church in Treviso.

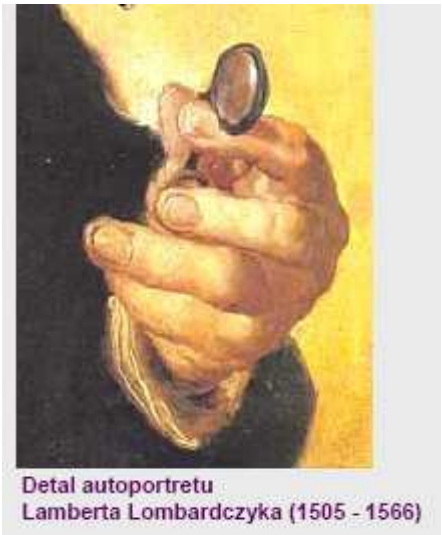
„Barber", detail - Jan Sanders van Hemessen



„Painter" (about 1565) – Piotr Breughel Older



Saint Peter, detail picture, „Hugh of St. Cher" – Crivellego (1352)



Detail of self portrait of Lambert Lomardczyk (1505 – 1566)

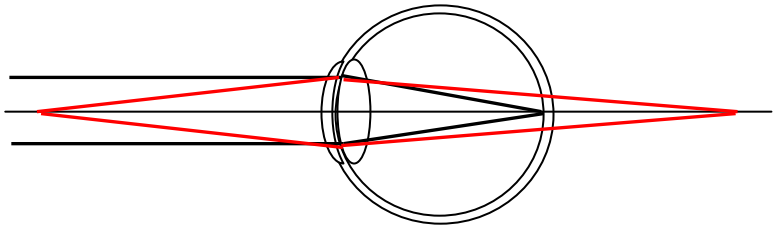
Fundamental part

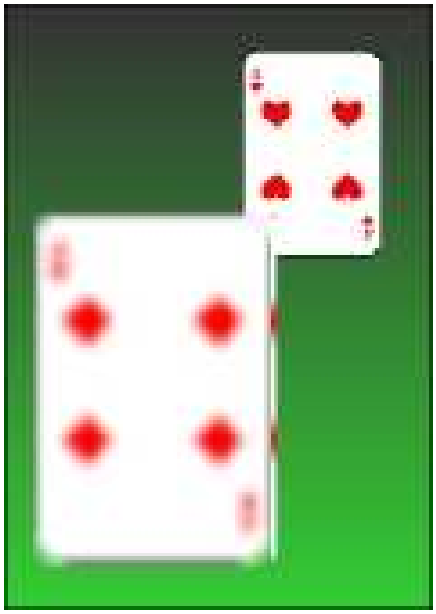
1. The teacher asks a question in turn:
- What is the sight defect that we have to do?
- What is this defect? Do you know someone with this defect?
- How can see a person with this defect?

Teacher together with the students formulate answers:

- **In most of the cases we are dealing with a sight defect associated with the human age (hyperopia).**
- **It consists in the fact that the eye lens is not able to set the focus (understood as the distinguishing details of the objects seen) on objects in a close distance.**
- **Man sees then as shown in this picture.**

In addition, the teacher explains that using the early prepared drawing.





Explanations to the drawings:
Figure shows a situation in which the eye lens "set" so that the sharp image formed on the retina of the eye is an image of objects arranged at a greater distance (the run of rays shown in black).
If the viewed object is closer (run of rays shown in red), a sharp image is created outside the retina of the eye.

The teacher asks a question:
- How to set focus the eye on watched object?
• **Changing the ability of focusing the lens of the eye.**
The teacher presents the Figers a, b, c, and asks:
- Explain the eye lens behaves, when the subject approaching the eye.
• Student: **Lens changes shape – the radius of curvature of the lens decreases.**

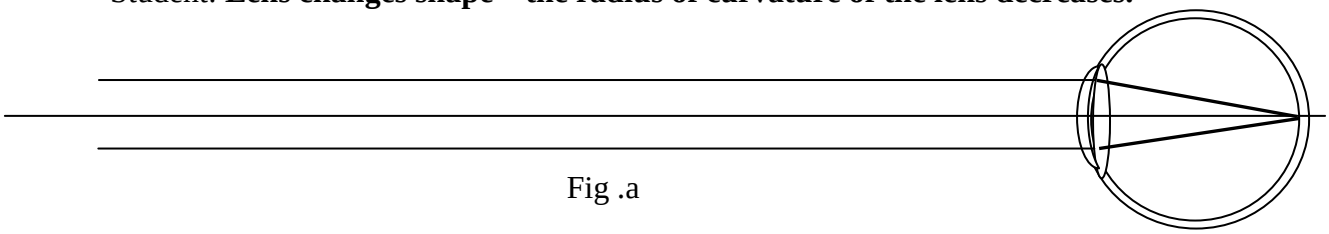


Fig .a

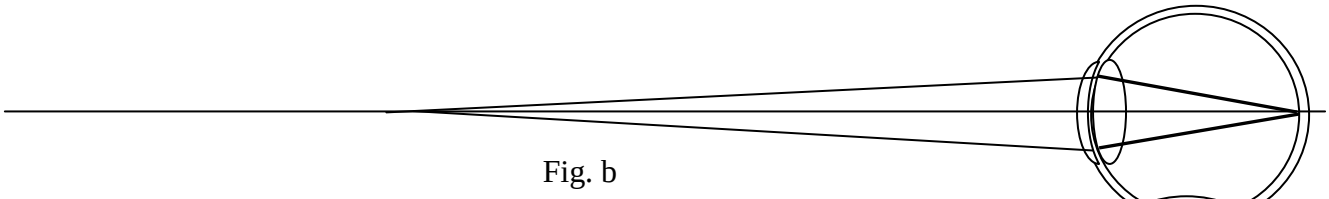


Fig. b

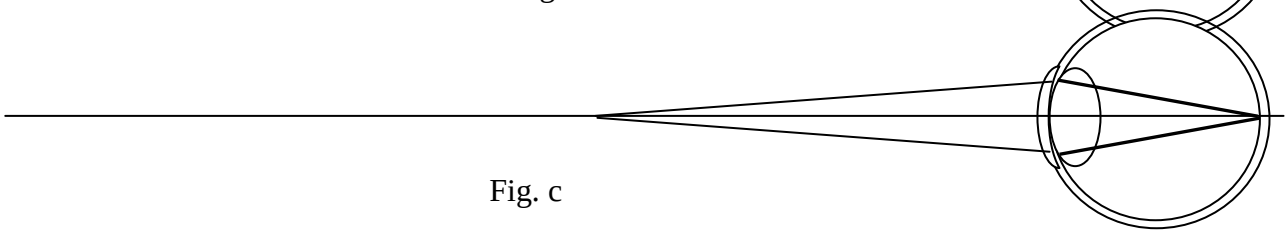


Fig. c

Teacher referring to the dependence of $1 / f = (n-1) (1/R_1 + 1/R_2)$ asks:
- How will this change of shape affect the focusing ability of lens?
• **Student: The decrease in R increases its focusing ability.**

Pupil draw a short note, in which bear the observations made.

For those interested students teacher is giving th data related to the rays of a human eye) for a small distance - 6 mm outer, inner - 5 mm, b) for a big distance - of 10 mm and 6 mm.

Consolidation of the given part of material can be resolve on tasks at the lesson:
- Knowing that the zooming of a healthy eye ranging from 23 mm to 19 mm, calculate how will change eye focusing capability (in dioptres) Assume: focusing capability Z of lens is Z=1/f.

- How the ability focusing the eye will change of a man, who initially looked at the stars and then moves eyes on a book set in a distance of 25 cm?

It is desirable that solutions were prepared as a multimedia presentation, with emphasis on the behavior of the sequence of calculations, which will be gradually presented as progress in solving the task.
To sum that part of lesson the teacher draws attention and compares the value achieved in the tasks.

2. Then the teacher returns to the problem of foresight.
Teacher:
- What defect of eye lens underlies the foresight?
• **Student: Focusing ability of lens is too small.**
Teacher:
- How can I correct the above defect of sight?
• **Student: By using the special focusing lens (only from XIII c.).**
The teacher points out that the eye lens and corrective lens create optical system whose capacity is the sum of the capacity of bringing together the two focusing lenses.
Complement this part of the task may be exercise:
A man see good the letters from a minimum distance of 40 cm. Calculate which corrective lenses requires his sight defect. Calculate the value of bringing together these lenses. (Tip: After applying the corrective lenses the eye see clearly at a distance of 25 cm).

It is desirable that solutions were prepared as a multimedia presentation.

Completion of lesson

The teacher asks for a joint supplement the text, pointing to the earlier information given and the solved tasks.
Complete:
- In Europe, the glasses first appeared in the *(time and place)*..... . *(end of XIII, Italy, Florence)*
- The inventor of the glasses is considered to be ..... . *(Salwino d'Armato degli armati from Florence)*
- The first spectacles were used to correct sight defects known as ..... . They used glass lenses were ..... . (foresight, convex)
- The impetus for the spreading of glasses "for reading" has become a widespread readership in connection with the invention ..... in 1456 year. (print)
- Man with foresight sees a well-placed items in ..... distances. *(bigger)*
- For viewing objects located near focusing ability of the eye is ..... than when we see more distant objects. *(bigger)*
- For viewing objects located near the radius of curvature of the eye lens is ..... than when we see more distant objects. (less)
- What is the focusing ability of a system consisting of eye lenses and lens of corrective eye glasses? *(total capacity of associating different elements of the system)*

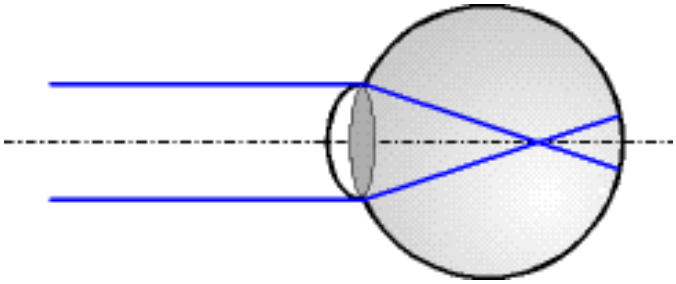
Additional Information: underlying invention, which are glasses is probably observation of images, that arise when on the card with the text we place flat-convex lens made of glass or quartz. They were called "lapides ad legendum" - "reading stones". You can ask students to comply with the following observation: cut, transparent plastic ball place on the printed sheet of paper and observe the size of letters seen in the way.

Additional work for students passionate in photography, can be a task to make photos of two subjects are set so, that the focus was set: a) at the closer object, b) at the further subject.

Homework

The teacher announces that homework will concerned with the other eye defect. Then presents the ready information:

- first descriptions of the sight defect is due Aristotle (more than 300 years BC), the defect has often been encountered in ancient Rome,
- defect is determined from the Greek word "myopia" which means "to squint",
- letter sent by the Duke Francesco Sforza of Milan to his ambassador in Florence (year 1462) for a contract "three dozen pairs of glasses, one dozen of these are suitable for distant vision, that is for the young, the second of those with close vision, namely to old, and the third to the People with normal sight,
- People with this defect see blurred objects very far away (fig.).



Homework:

1. Please write how is called and what is the description of the defect of sight, which has been mentioned in the given information? Explain using a drawing, how to make the image on the retina in the case of the human eye with this defect. How do I can correct this defect of sight?
2. Task: A man apparently sees and reads from a distance of 15 cm. After application of corrective lenses "eye" sees clearly from a distance of 25 cm. Calculate the capacity of focusing lenses. Note the sign of the number received.

References:

1. Zając M., Sarnowska-Mobrat K., „Historia optyki okularowej” [w:] www.optyka.if.pwr.wroc.pl/optometria/wyklady/historia_okolarow.pdf
2. Bieganowski L., Małek J., „Nowe przyczynki do historii okularów w Polsce w XVI w.
3. Prezentacja multimedialna: Witkowska A., „Okulary i soczewki kontaktowe”

Reflection

Attention to the lessons conducted "Glasses as a simple optical device that is ...".

There were three classes: one class, in which physics was taught in the expanded, but two classes with the fundamental level of physics.

1. In all classes present physics in a historical context seemed a risky venture - the students prefer the briefly presented problems in a classroom, as a minimum. Despite, the lessons aroused interest in both the historical background and physical dependences.
2. The historical background has helped catch the theme of lessons by the students interested in the humanities.
3. In classes, in which physics is taught at the fundamental level, with a greater attention had to approach the tasks and to devote more time to solve them.
4. Number of learned information seems to be greater than in the "traditional" lesson.
5. Presented exercises could be considered as exemplary and as such can be modified. This applies especially to the physics "expanded" classes.

Note: This lesson was conducted during the implementation of the European Project FP7 Science in Society-on History and Philosophy in Science Teaching (HIPST).

Questionnaire analysis related to the lesson
„GLASSES AS A SIMPLE OPTICAL INSTRUMENT
or from what it started ...

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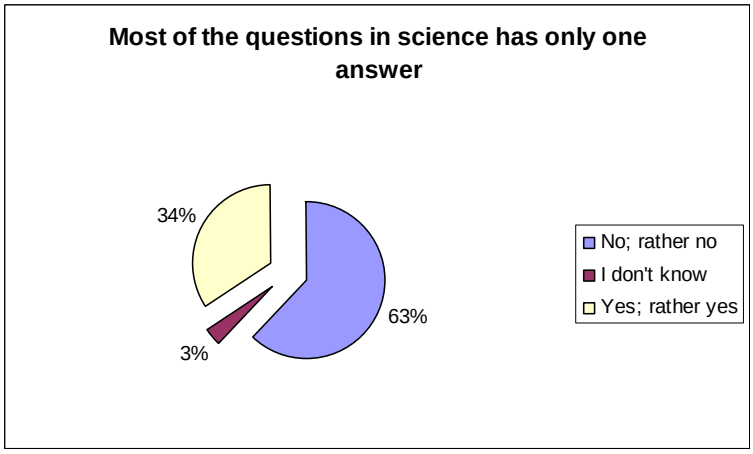
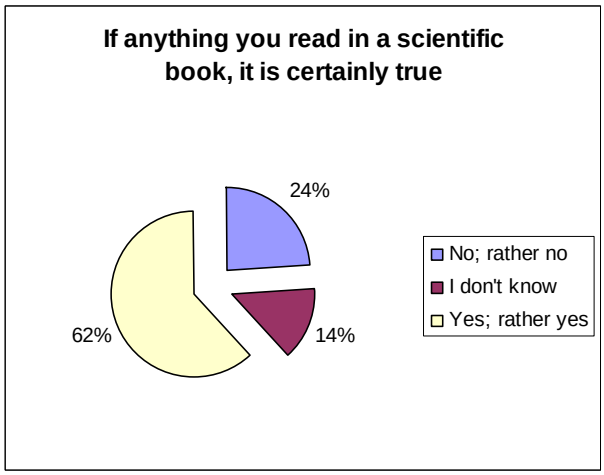
The questionnaire study was conducted in two classes: the mathematics and computer profile, which carried out a lesson in "traditional way", ie. without the historical elements and biological - chemical class, in which the lesson was carried out within the HIPST programme.
Analyzing the survey I focused on student responses, which significantly differed in the class profiles and on the responses that were incomprehensible to me, or surprising. Complement to the survey there was a free conversation with the students, whose aim was to obtain additional information on specific questions of the survey.

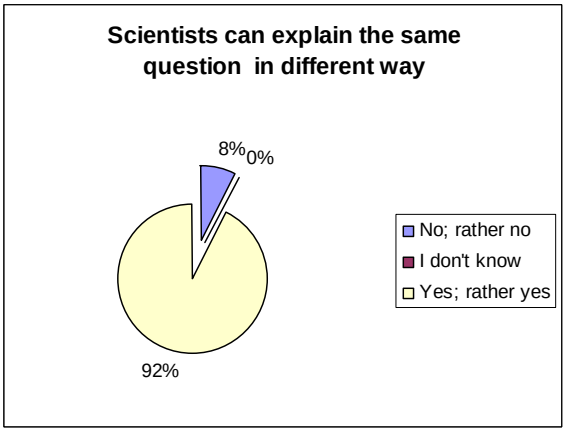
I. Most of students disagreed with the statement that "*most of the questions in science has only one answer"* stating - no, rather not. From the words spoken students we can assume, that this question has been understood in the context of the history of science. Often the views of researchers on the fundamental issues of science underwent radical change, therefore, probably, the surprising answers on this question. In both classes, the results of the survey were very close, so the final results have been included in one common diagram.



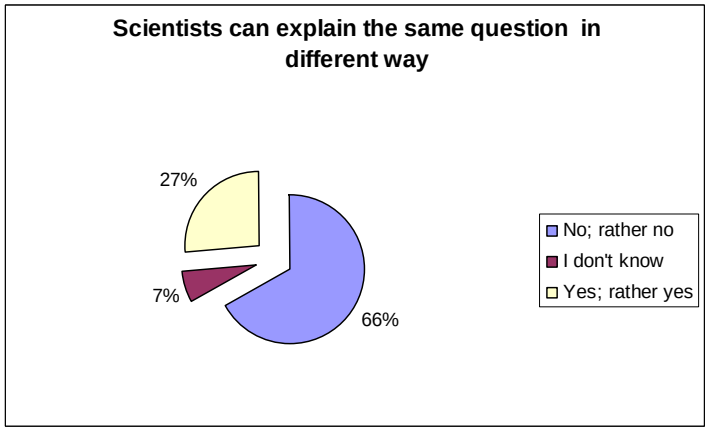
II. A large part of the students agreed with the statement *"if anything you read in a scientific book, it is certainly true."*
In addition, students were asked to explain the confidence in the information contained in these books. Major role, according to students, plays here the name of author of the book and additional information such as on the cover of a book proving the reliability of the information presented in the book.
Similar as in the previous section responses in both classes were presented on a common diagram.



III. The following diagrams present the answers to the same question given by the students of two different classes. The first is a biological-chemical class, the second - mathematics and informatics class.



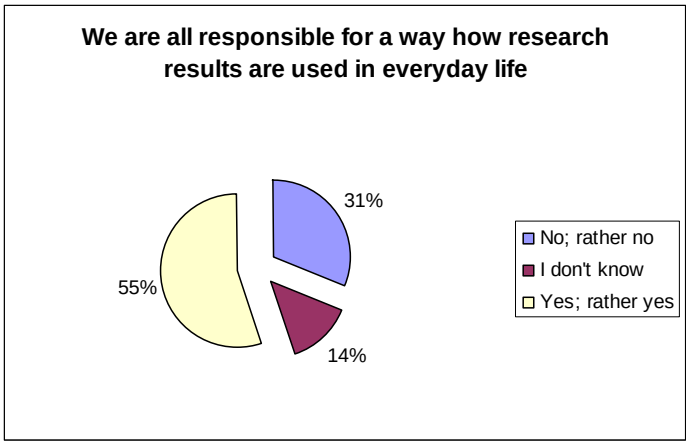
biological-chemical class



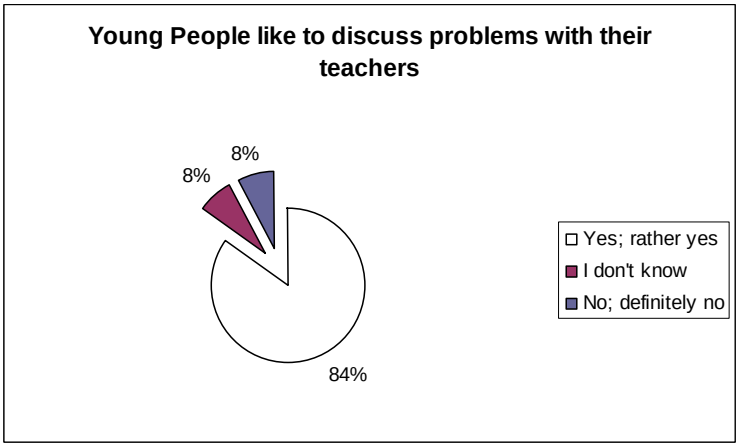
mathematics and informatics class

So, varied results may be associated with the specific profiles of classes participating in the test.

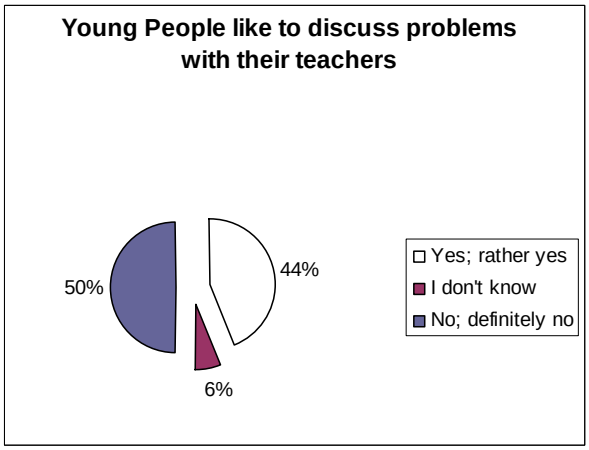
IV. Most of the students participating in the survey agreed with the statement that *"we are all responsible for a way how research results are used in everyday life."* Participation in a way how research results are used in everyday life is understood by students as their use of technical "novelties", so often what is currently launches fashion.



V. The following diagrams present the answers to the same two questions in a class of chemical and biological profile and mathematics and informatics profile.
Answers to the first question provide information about the preferred ways of learning in classes with different profiles: in biological – chemical class the best way of learning by students is to discuss and analyze the problems together with the teacher, while in mathematics – informatics class other ways of learning are preferred.

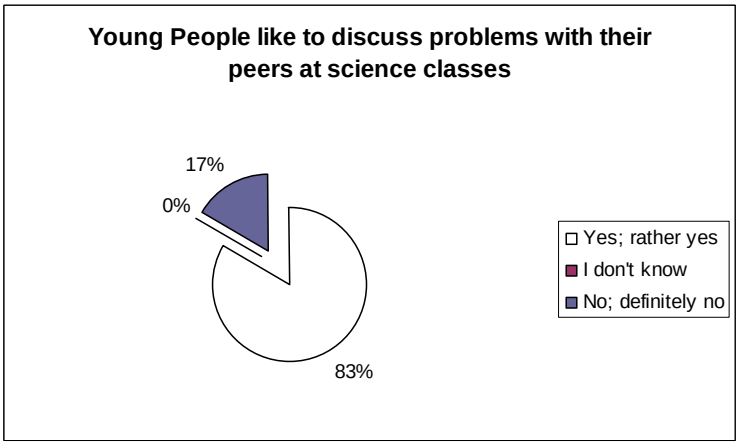


biological-chemical class

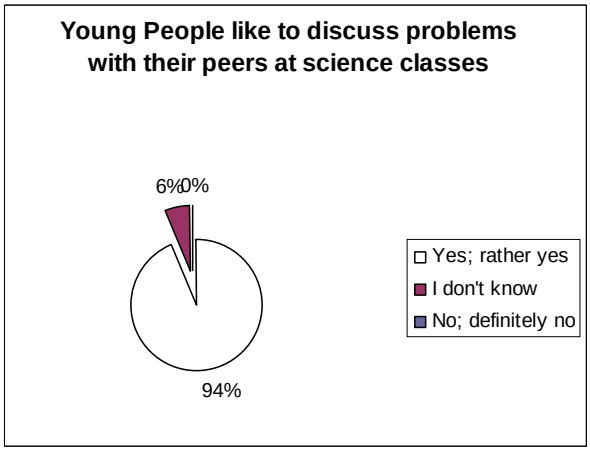


mathematics and informatics class

Answers on the second question suggest that learning in a group with their peers has a large number of followers and it doesn't depends on the type of class.



biological-chemical class



mathematics and informatics class

Additional remarks

In order to increase the readability of the results of the survey responses were grouped into three classes:

a) yes, rather yes,
b) I do not know,
c) no, definitely not.

Five-step scale is rather difficult to interpret.

In a questionnaire there is no explicit reference to the historical and philosophical elements and attempts to sound out opinion on their advisability in the classroom. in my opinion is difficult. This type of study should preferably be made after the series of classes conducted in an innovative way. One lesson is not enough to cause significant changes in the awareness of students. This analysis can be treated as a first attempt to study opinions of students on topics having a scientific nature.