Description of Case studies of – Optical microscope since the first to the contemporary one, for exchange within the HIPST project

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1. **Title:**

"Optical microscope since the first to the contemporary one."

Key words: *lens, history of microsope, microscope, micorscope's magnification, observations.*

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3. Summary:

In Polish National Curriculum for Lower Secondary School there aren't included standards related to the construction and rule of operation of optical microscopes. However, students have to know different kinds of lens and learn the lens' equation. This theme is an obligatory standard in National Curriculum for Higher-Secondary School, but there is no word saying about microscope's history. Students learn at once how microscope is built, how to construct picture of object that is observed by use of microscope and are acquainted with the magnification's formula. There is lack of historical elements of coming into existence microscope, that will connect all the above elements. It brought an idea ***– initiation one extra lesson about history of microscope!***

*This extra lesson (see Annex 1) was executed between two lessons: "Kinds of lenses and lens' equation" and "Optical instruments". The lesson allowed students for practical use of geometrical optic's laws. The lesson: "****Optical microscope since the first one to the contemporary one****" was aimed at raising an interest of students in historical aspects of emerging microscope, the most famous constructors of first microscopes and objects, that were discovered by the use of first microscope.*

This theme may be realized in lower-secondary schools and all types of higher-secondary schools.

4. Description of Case study

Lesson was given to students from different type of schools:

- *lower-secondary school, students' age: sixteen and seventeen,*
- *vocational school, students' age: eighteen and nineteen,*
- *secondary-technical school, student's age: nineteen and twenty.*

Lesson in all class was given in similar way. Firstly students were given "Worksheets", where were placed some exercises. Students completed exercises during watching presentation "Optical microscope since the first one to the contemporary one", which was prepared and talked over by the teacher. The presentation has started with explanation of word "lens" etymology and" magnifying glasses" origin. Secondly, I discussed Zacharias and Hans Jansens' contribution to the microscope construction.

Next I told about Antonie van Leeuvenhoek's life, his research and discoveries that he made using his own microscope (see Annex 4). Leeuvenhoek has sent letters to the Royal Society saying about his discoveries. Robert Hook was reading this letters and started to be interested in microscopes. He constructed also his own microscope. I discussed with students Hook's life, construction of his microscope and his investigations. Then, I told students about contemporary optical microscope, its construction and how it works (taking into account the optical geometry laws). Finally, I acknowledged students with magnification formula
of the microscope. After showing presentation In some classes I checked if students made exercises correctly, but in some others I didn't, because I would like to motivate them to work, by giving extra marks. Then students solved a problem about microscope's magnification that was implemented into worksheet. One of the students was solving a task on the blackboard and the rest of class wrote the solution in the worksheets. Last, but the most important lesson's element was watching different kind of microscopic preparations. Students willingly used microscopes and specimens, changed objectives and other set-ups of microscope's parameters, especially its magnification. Their happiness could be noticed when set-up of microscope was correct and image of preparation was well visible and clear. If they had problems with arrangement of the microscope, the asked each other for help, eventually they asked also teacher for help. At the end of this lesson students completed a questionnaire concerned with "opinion of students on nature of science".
During the next lesson students gave back worksheets, with completed tasks of homework. I checked homework and gave the marks. In classes in which I didn't check exercises during the lesson, I did this after lesson and also gave one more extra mark. I discussed with students their answers for questions that were given as a homework.
At one of these lessons there was visitation of headmaster Mrs Agata Dziedzic and Mrs Liszewska representing provincial education authorities. They evaluated lesson as very interesting. They told also that there have been good time organization, but students were very active and interested in the topic of the above lesson.

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

First microscopes were constructed in Holland ica.1490. They were built by Hans and Zachary Jannsens, but at that time there wasn't any practical use of them. Galileo was interested in this device, but he paid attention to watching objects that were very far from the Earth and had big size. Antonie von Leeuvenhoek has been interested in magnifying glasses. At the beginning he was a student in fabrics store. There magnifying glasses were used to count the threads. He was trying to increase magnification of glasses. His grinding and polishing method used for thin lens gave a good result – gave magnifications up to 270 times. This method allowed Leeuvenhoek to construct his mentioned above microscopes and to make observations.
As the consequence Leeuvenhoek made the biological discoveries, from which He is known. Through the use of his microscope He saw and described: the bacteria and microbes in a drop of water, the particles of blood circulation in capillary vessels, red blood cells, sperm cells. Leeuvenhoek forwarded his findings to the Royal Society, where Robert Hooke played the role of President and who became interested in Leeuvenhoek's discoveries. Hooke made a copy of an optical microscope of Leeuwenhoek and improved its appearance.
Further his microscopes were improved inter alia by the three lenses. Hooke looking through a microscope at cross-sections of cork from oak cork discovered the

structure, which today is called a cell. In the eighteenth century several technical innovations were introduced, which facilitated holding of microscope, which made the microscope was becoming a more popular device among scientists. In 1830 Joseph Jackson Lister reduced the problems of spherical aberration - several weak lenses joined together while maintaining a distance between them. The result was a good zoom and picture without haze. In 1878, Ernst Abbe formulated the mathematical theory, which correlated the resolution with the wavelength of light. His model allowed to calculate the maximum resolution of the microscope. In 1903, Richard Zsigmondy expanded ultramicroscope, which allowed viewing the objects smaller than the wavelength of light. In 1932 Frits Zernike invented phase contrast microscope, which allowed the study colorless and transparent biological materials. In 1938 Ernst Ruska built an electron microscope. The possibility of using electron microscopy has contributed significantly to increase the resolution and the boundaries of research have expanded. In 1981, Gerd Binnig and Heinrich Rohrer invented the scanning-tunneling microscope, which gives three-dimensional image of objects smaller than atoms.

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

The target groups are the students of secondary schools and junior high schools of various types. It is the youth between 14 and 18 years of age. The activities may be carried out during a lesson at school (high school and upper-secondary education), or as extracurricular activities such as physical circle at school.
Concepts faced during this lesson are: magnifying glasses, lens, microscope, microscope zoom, the focal length of eyepiece, focal length of objective. Some of these concepts are familiar to students. During the course, students familiarize themselves with the construction of a microscope, which is correlated with the teaching of biology. They learn how the image of the object viewed through a microscope is created. Using a school microscope they are watching the various samples (plant and animal tissues), which are also watching at the lessons of biology. Besides this, the course is to teach the calculation of microscope magnification, if the following data are known: length of tube, the focal length of eyepiece and focal length of objective.
After these activities is expected that students would be better at using a microscope and understand how the microscope work. The inclusion of historical elements encourage students to deepen their knowledge on the subject and motivate for action – observations with the use of microscope.

7. Activities, methods and tools of learning

The methods used in the conducting of of classes are:
- Seeking: a talk with the students (by way of questions and answers);
- Practical: completion of work papers, solving tasks, carrying out observations using optical microscopy.

Educational tools, which were used during classes:
- the ppt presentation "Optical microscopes", computer, multimedia projector, worksheets, optical microscope.

8. Difficulties in teaching and learning

In the course of activities I didn't encounter any difficulties as regards to the acquisition of knowledge by students, lack of the right concepts or the proper use of the microscope.
After the lesson, the special survey on „Nature of science" was carried out, but the first class we had to improve the questionnaire. This was due to its too complicated structure, which the Polish students didn't understand. They had difficulty answering, because the questions (especially in the II part) were too long. After simplification of survey form, there were not problems at all. (see Annex 2 and 3).

9. Teacher's pedagogical competencies

Nowadays Polish practice of teaching doesn't value implementation of History and Philosophy of Science in education. For that reason teacher who would like to teach in the above proposed way, should be interested in source historical materials and literature (this kind of materials are published mostly in foreign languages in different magazines or in Internet) and should be convinced of his own pedagogical success.

10. Documentation (evidence) of studies

Questionnaire about student's consciousness of the range of researches and about the spectrum of understanding the nature of science and its importance for society and themselves.
Analyses of questionnaire – see Annex 3.

11. Further professional development of users

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http://www.mindspring.com/~alshinn/Leeuwenhoekplans.html

12. Written literature resources

- *Scenario of lesson with the worksheet,*
- *presentation ppt: „History of microscope", "Optical microscope since the first to the contemporary one"*
- *Paper on: „Leeuvenhoek's microscope replica,*
- *Description of Case studies: "Optical microscope since the first to the contemporary one"*
- *Publication M. Sadowska: Optical microscope since the first to the contemporary one"- proposition of lesson within HIPST Project, Science Teaching, 31/2009, pp. 26-36..*