OPTICS LESSONS BASED ON HISTORY AND PHILOSOPHY CASE STUDIES

UT 4 – Torun, Poland

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Plan of presentation

I. Introduction

II. Factors influencing effectiveness of teaching

III. Why we selected optics?

IV. Description of Case studies

V. National WWW page of HIPST

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I. Introduction

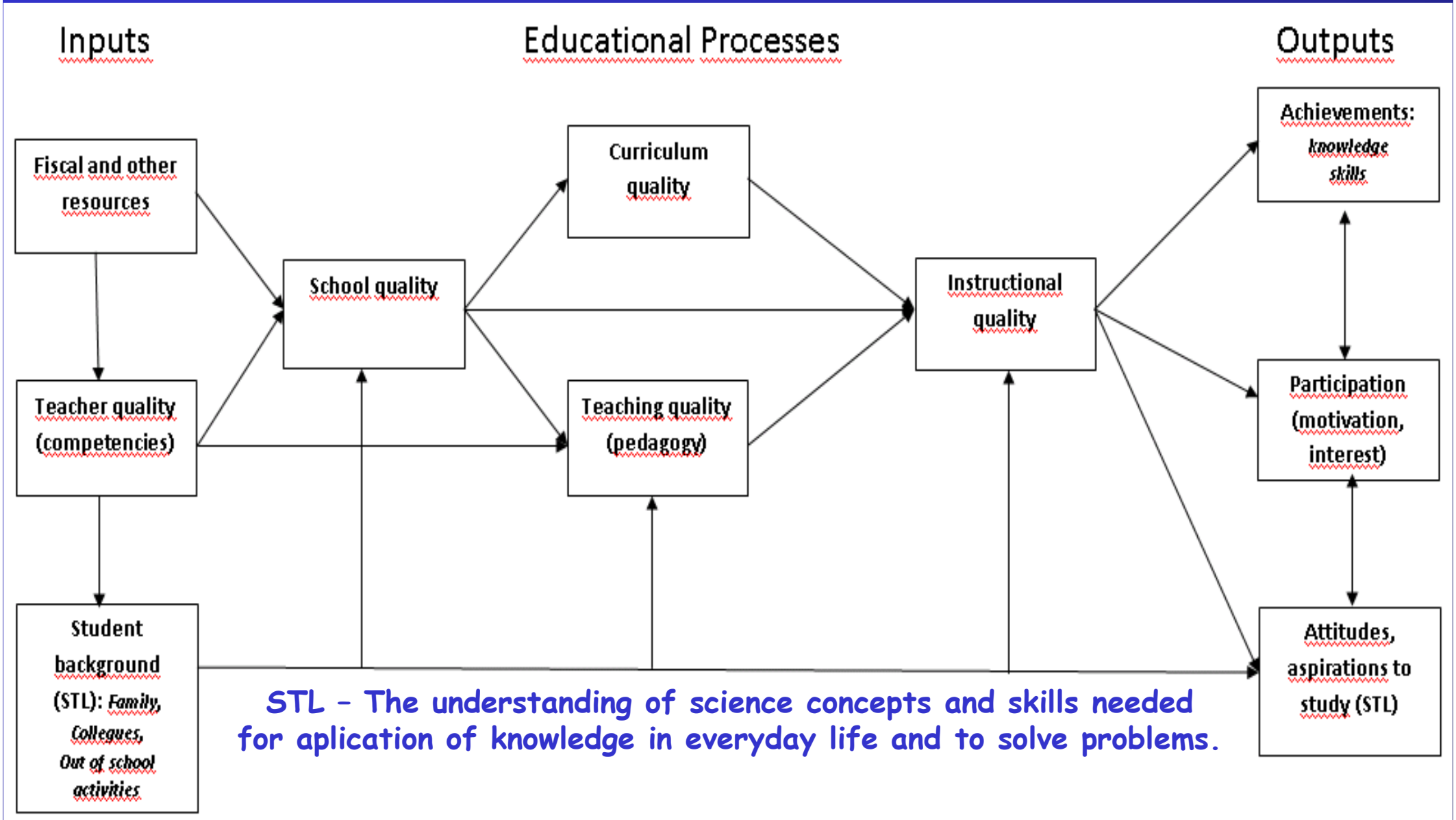
1. The features of our time:

- globalisation,
- economy development based on knowledge,
- social transformations,
- dramatically accelerating progress in new technologies (including communication based on ICT). New jobs, but...
- the fall in young people's interest in science and math !!!

2. Implications for science educations:

- science for all not just for some (curricula and STL),
- science education for innovations (inquiry methods of teaching), teacher competencies and their enthusiasm as a background of success.

II. Factors influencing effectiveness of teaching



STL – The understanding of science concepts and skills needed for aplication of knowledge in everyday life and to solve problems.

II. Factors influencing effectivenes of teaching

Teacher quality

Teacher competencies (placed in teacher training standards):

1. Subject knowledge
2. Subject application

   (pedagogy, methodology of teaching – learnig)
3. Class management
4. Assessment (evaluation), recording of students' progress
5. Further professional development

   (for reflection and creativeness, being able to innovate: applying inquiry methods, ICT, foreign languages in collaboration, etc.)

III. Why we selected optics?

1. We have access to the unique in Europe original materials of great scientists as Witelo (XIIIc.) and Copernicus (XV c.).

2. We are collaborating with astronomers within Faculty of Physics and Astronomy and with specialists of the bigest in Poland Astronomical Center, using optical instruments for observations.

3. Collaborating with Professor Riess Group: „Higher School Didactics and History of Physics" at the University of Oldenburg we reconstructed already some historical experiments (also from optics) and Regional Museum in Torun have collection of historical glasses.

III. Why we selected optics?

4. Collaborating with teachers we identified the optics issues in Polish Core Curricula, where philosophy of HIPST should be implemented *(see Report on „The place of HIPST in new Polish Core Curricula" (Eng.)*

5. We wish to present the variety of active methods of teaching as: hands – on experiments with the use of replicas, reproductions of famous historical investigations by inquiry method, play with instruments – constructions, watching films, using Internet, etc.

IV. Description of Case Studies

The following Case studies have been selected:

1. *Witelo's studies on rectilinear propagation of light*, by Justyna Chojnacka.
2. *The contribution of Nicolaus Copernicus observations to the reform of calendar*, by Magdalena Czerwińska.
3. *The telescopes at school, that is as to be Galileo…* by Krzysztof Rochowicz.
4. *The glasses as a simple optical instrument, or from what it started …*, by Janusz Kosicki.
5. *Optical microscopes from the first to the contemporary one*, by Magdalena Sadowska.

IV. Description of Case Studies

Methodology of work:

- *We have created the common e-mailing list, all materials elaborated by the group members and consecutive actions are discussed and corrected by e-mails and during the face to face meetings (recently 1 per two weeks).*

- *Consecutive steps of work where as follows:1. Study of the available literature, 2. Writting the scenario of lesson based on the Case studies, 3. Preparation of instruments and ppt presentation, 4. Conduction of pilot lesson and reflection, 5. Description of Case studies, 6. Corrections and dissemination of results.*

- *Furthermore, two M.Sc. degree works were supervised: 1. Active methods for motivation students towards effective lerning of physics with the use of HIPS. 2. Development of inquiry – interactive methods of teaching based on Witelo and Copernicus studies.*

IV. Description of Case Studies

Ad 1: Witelo studies on rectilinear propagation of light

- Vitelo – Polish scholar from XIII century

His work „*Perspective*” which might seem devoted to optics, is also the basic geometry work. It also deals with human physiology and one chapter is an eye description with its mechanisms. Witelo took into account the subconscious action of mind, its influence on „seeing”. There were many interests in Witelo's activities, he was not only the naturalist, but also mathematician and philosopher.

He was born in 1230

- Planning the lesson – writing scenario

Lesson, has been carried out in the second class of higher secondary school (adolescents of 18 years). Firstly students fulfilled the Questionnaire on „Nature of science” and started to answer on properties of light, including recognition of students' misconceptions.

IV. Description of Case Studies

Ad 1: Witelo studies on rectilinear propagation of light

- Execution of Vitelo theory and experiment

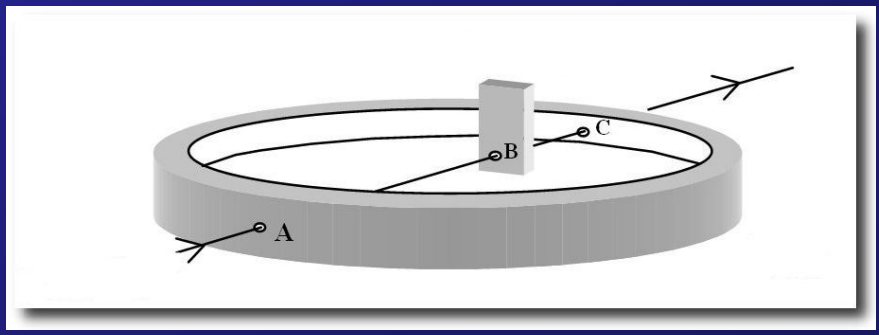
Talking over the understanding of light by Vitelo and comparison with contemporary concepts. Execution of experiment providing evidence of rectilinear propagation of light with the use of laser and historical device of Vitelo.

- Observations and conclusions

Students were acknowledged with the particular stages of experiment made with the use of inquiry method.

- Aplication of rectilinear propagation of light to everyday phenomena

Students worked in groups solving particular tasks related to shadow.



IV. Description of Case Studies

Ad 2: The contribution of Nicolaus Copernicus observations to the reform of calendar

- Target groups.

Lesson for students from lower secondary school at the advaced level (13-16).

- Operational aims. Student:

1. knows properties of light – rectilinear propagation and reflection,
2. understands the function of mirror and reflection gnomonic method,
3. knows the creation of shadow and its everyday aplications,
4. conducts the experiment of N. Copernicus on astronomical table.

- Historical introduction on famous Copernicus observations.

Introductory lesson to explain interdisciplinary character of Copernicus experiment (elements of physics, astronomy, geography, history, philosophy). Planning observations, working groups, elaboration of results.

- Fundamental lesson - conclusions, reflections, remarks.

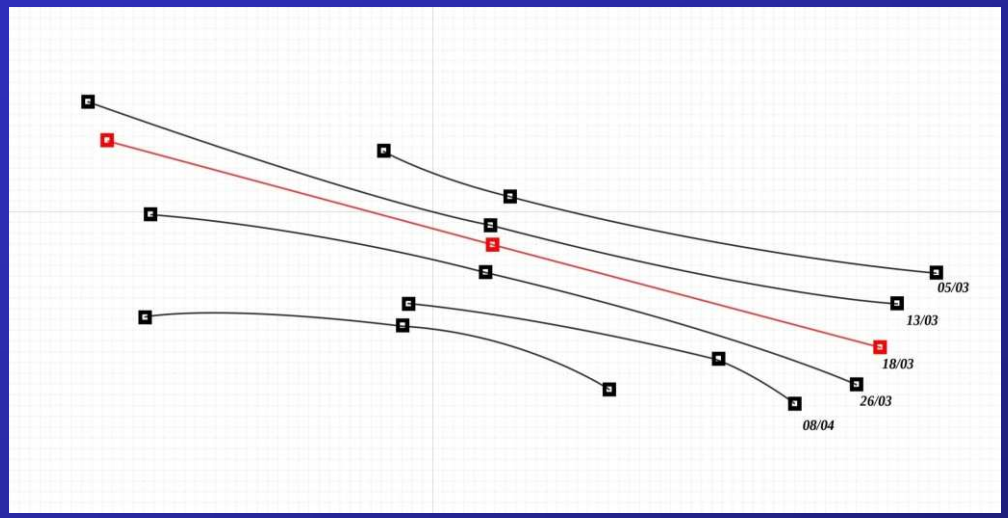
The results of students where compared with the Copernicus observations, improvements for the next experiment of finding of equinoxes.

IV. Description of Case Studies

Ad 2: The contribution of Nicolaus Copernicus observations to the reform of calendar

Experimental setup: mirror

The group of observers with teacher



Plot showing results of student observations

Copernicus place of studies

IV. Description of Case Studies

Ad 3: The telescope at school, that is as to be Galileo…

- Target groups.

Lesson for students from higher secondary school at the basic and advaced level (16-18).

- Operational aims. Student:
  1. knows, that there are two kinds of refractors, which give straight or reverse image,
  2. knows, that there are two kinds of telescopes – refractors and reflectors.
- Historical introduction on Galileo first observations using telescope.

  It was exacly 400 years ago when Galileo used telescope for observations for the first time (watching at the replica of this telescope).
- Fundamental part of lesson devoted to recognition of different lenses and construction of hands – on made telescope.

  This work finished with discussion and felling in subject worksheet.

IV. Description of Case Studies

Ad 4: The glasses as a simple optical instrument or from what it started

- Target groups.

  Lesson for students from higher secondary school at the advaced level (16-18).

- Operational aims. Student:

  1. applies the concepts of the focus, the focusing ability, the lens focal length,
  2. explains the human eye operation,
  3. understand how to correct foresight, solves mathematical tasks,
  4. knows the history of glasses construction development.

- Historical introduction on glasses discoveries.

  Formulationg the title after watching the scrap of the film "Name of the Rose".
  Showing the presentation documenting, creation of glasses in the history.

- Fundamental part of lessons showing different sight defects.

  With the use of drawings explanation of hyperopia and myopia – solving tasks.
  Completion of lesson, homework.
  Teacher's reflection.

IV. Description of Case Studies

Ad 4: The glasses as a simple optical instrument or from what what it started

„Barber", detail - Jan Sanders van Hemessen

„Painter" (about 1565) – Piotr Breughel Older

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

IV. Description of Case Studies

Ad 5: The optical microscopes from the first to the contemporary one

- Target groups

Lesson was given to students from lower-secondary school (16-17), vocational school (18-19), secondary-technical school (19-20).

- Historical introduction on development of microscopes.

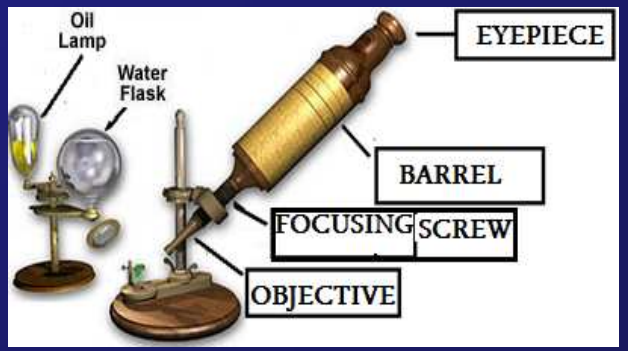
The main discoverers: Zacharis, Hans Jannsens, Antonie von Leeuvenhoek, Robert Hooke, Richard Zsigmondy, Frits Zernike, Ernst Ruska, Gerd Binnig and H. Rohrer.

- Showing presentation, answering questions placed in the Worksheet.

There was 7 questions to answer with the help of teacher (including historical ones).

- Acquisition of knowledge on construction and operation rules of microscope, carrying out observation of different media, homework.

- Completing questionnaire on „Nature of science" by students.



V. National WWW Page of HIPST

- The most important, selected materials on HIPST Project were placed at Polish web page of HIPST: (http://hipst.fizyka.umk.pl). *There are general information about the main activities within the project: Materials (scenarios, presentations,…), Seminars, Meetings, etc.*

VI. Publications

1. *Energy – historical, interactive and pedagogical path*, G. Karwasz, A. Karbowski, J. Turło, J. Kruk, Girep 2008, Nicosia, Cyprus.
2. *Introduction of history and philosophy of science elements for curriculum development*, J. Turło, G. Karwasz, K. Służewski, A. Karbowski, K. Przegiętka, 7th IOSTE Syposium for Central and Eastern Europe Proceedings, 2009, pp. 165-171.
3. *The solar calendar of Nicolaus Copernicus, Part I*, Z.Turło, A. Witkowska, J. Turło, Nauczanie Przedmiotów Przyrodniczych, 29, 2009. pp. 9-17.
4. *Spectacles as a simple optical device, starting from the history*, J. Kosicki, Nauczanie Przedmiotów Przyrodniczych, 29, 2009. pp. 23-27.
5. *Europejski projekt FP7 History and Philosophy in Science Teaching (HIPST)*, J. Turło, G. Karwasz, K. Służewski, A. Karbowski, K. Przegiętka, Nauczanie Przedmiotów Przyrodniczych, 30, 2009, pp. 41-48.
6. *The solar calendar of Nicolaus Copernicus, Part II*, A. Witkowska, Nauczanie Przedmiotów Przyrodniczych, 30, 2009. pp. 25-29.
7. *The solar calendar of Nicolaus Copernicus, Part III*, M. Czerwińska, Nauczanie Przedmiotów Przyrodniczych, 30, 2009. pp. 30-40.
8. *Development of concept on shape of Earth,* J. Szubiakowski, Nauczanie Przedmiotów Przyrodniczych, 31, 2009, pp. 8-12.
9. *Interactive education – exhibition on optics „From Witelo to optical tomograph”,* G. Karwasz, Nauczanie Przedmiotów Przyrodniczych, 31, 2009, pp. 20-25.
10. *Optical microscope since the first to the contemporary one – HIPST lesson proposition*, M. Sadowska, Nauczanie Przedmiotów Przyrodniczych, 31, 2009, pp. 26-36.
11. *Optics lesson with the use of Witelo studies,* J. Chojnacka, Nauczanie Przedmiotów Przyrodniczych, 32, 2009, pp. 16-22.
12. *Telescope at school lessons – to be Galileo themselves*, K. Rochowicz, Nauczanie Przedmiotów Przyrodniczych, 32, 2009, pp. 23-28.

VII. Expectations

- We would be intrested in the further development of the exhibition's collection, (to construct replicas of some others historical instruments).
- We would like to introduce HIPS elements to the Polish curricula.
- We are planning to establish the Science Center in Torun as well!

But, have we learnt to teach? …

Thank You for your attention!