FaSMEd

**Raising Achievement through
Formative Assessment
in Science and Mathematics
Education**

Real and apparent size of objects seen under a microscope

Subject:	Science
Age of students:	13 - 14 years
Hardware:	Clickers, teacher PC, projector, microscopes
Software:	*Je lève la main* (student response system)
	Optikos: simulation of light rays
Functionalities:	Sending & displaying, processing & analysing, providing an interactive environment
Time:	6 lessons of 1 hour each
FaSMEd partner:	Ecole Normale Supérieure de Lyon
Short Abstract:	This 6-lesson sequence is about the use of microscopes both in Physics and science of life and Earth.

1. Content

This sequence has been done both in Physics and in sciences of life and Earth lessons. The objectives were different but the common object was the microscope and the ideas of enlargement or magnification and resolution. Lessons were organised in parallel in the two subjects with a common lesson whose goal was the determination of the real size of human gametes.

2. Activity

2.1 Aims

Objectives of the lesson in terms of knowledge and competencies to acquire:

- Science of life and Earth:
  ◦ knowing the characteristics of shape, mobility of human gametes
  ◦ knowing the characteristics of size of human gametes
  ◦ being able to observe and to take information with a microscope
  ◦ being able to use a scale in order to calculate the real size of an object starting from its image

- Physics:
  o knowing the difference between convergent and divergent lenses
  o knowing the vocabulary: object vs image
  o being able to obtain an image on a screen using a convergent lens
  o being able to understand why and how this image is obtained
  o being able to find the focus of a convergent lens.

2.2 Structure / Methodology

Two first sessions

- *Physics*: study of two types of lenses: convergent and divergent starting from the students' knowledge.

Questions are asked orally using a presentation (see "r&a size-session1-slides"). Since the first class of college, students have already used magnifying glasses and microscopes: therefore, they naturally propose these two instruments. These two instruments have in common lenses, which is the starting point of the study.

In the second part of the lessons, students work in group. They have at disposal different objects (a plate of glass, 2 convergent lenses f=16cm and f=3cm, a divergent lens and an eyepiece) that they have to classify; they also have at their disposal a text written in font 6.

The final report of the different groups aims at classifying those that "enlarge", those that are neutral and those that "reduce". The session ends with a quiz (see "r&a size-session1-quiz") that will be re-use in the next session.

- *Sciences of life and Earth*: observation and drawing of human reproductive organs.

Practical work (see "r&a size-session1-activity") about the observation and the drawing of a spermatozoid with microscopes. The final survey (similar to "r&a size-session1-quiz") aims at

knowing the students' knowledge about scales and units of measurement (and the conversion between them).

Second Session (Physics)

How does a convergent lens work?

This session aims at giving students an idea of the geometrical optics and at giving the scientific vocabulary, distinguishing object and image, drawing and schema, real size and observed size. The quiz (see "r&a size-session2-quiz") gives teachers a landscape of the students' knowledge after these two sessions.

Third session

Co-animated in physics and science of life and Earth: calculation of the real size of an object using scales.

Determining and using a scale is not a competence to be worked in science but in mathematics even if in science of life and Earth the differentiation of real and apparent length of an object is an important issue. In the same time, the difference between object and image can be an opportunity for students to re-use their skills. In this common session, students have to decide which of the two lego bricks that are on their table is represented in the document they have at their disposal (see "r&a size-session3-activity"). The image that is represented on the sheet has the same length than the real 2 times 6 lego brick but represents the 2 times 3 one.

The second activity brings students to give the real size of a spermatozoid head starting from a drawing given with the scale.

Two fourth sessions

- *Physics*: synthesis built with students about convergent lenses

During this session, students work on a simulation of light propagation in term of ray using a software (optikos) as well as experimenting with a real lens. The goal of the session is to build with students a comprehensive and structured report of the mode of action of a converging lens. At the end of the session, students take a summative assessment (see "r&a size-session4-test").

- *Sciences of life and Earth*: based on the previous knowledge about spermatozoids and ovums as well as about scales, determination of the real size of human gametes.

Leaning on the previous lessons, students have to give the size of human gametes starting from observation with microscopes.

2.3   Technology

The technology is used in different ways during this lesson: as a means of communication allowing teachers to display questions, and to collect and display students' answers, as well as simulation tool enabling to illustrate the propagation of light through a lens.

Providing a dynamic tool as an interactive environment

The use of the simulation software gave an opportunity for students to experiment with ray of light. The simulation was directly linked to the observation of the real phenomenon but allows to multiply the experiments. In that sense it participated to the formative assessment process by allowing students to be actors of their own learning.

2.4   Aspects of Formative Assessment

The student response system allowed to collect quickly the answers of all the students and to have them organised in tables but also to have a direct feedback in the classroom. The possibility of sending and sharing information is the functionality of technology that has supported teachers in establishing where the learners are in their learning.

On another hand, the software Optikos provided a dynamical environment that allows experiments in a simulation environment and feedback gives students information about their understanding of convergent lenses.

Establishing where the learners are in their learning

This practice of assessing competencies through quizzes allows teachers to detect the main students' difficulties in real-time in order to propose immediately remedying activities adapted to students' need. Quizzes have been used in different moments of the lesson, for different purpose: taking stock of the students' conceptions, or the students' knowledge, establishing where the learners are after a lesson.

The first quiz aims at taking stock of the knowledge of students regarding the units of measurement as well as the knowledge of students relatively to the real size of human gametes. It allows teachers to understand better where the learners are and to specify the vocabulary that will be used during the lesson.

The second quiz aims at better understanding the difficulties students have relatively to the new concepts that appear in the lesson. In Physics, it is more specifically related to the Physics concepts and the scales, and in Science of life and Earth to the human system of reproduction. This quiz is used during the process of learning and allows teachers to modify their lessons depending on the students' answers.

3.   Further Information

At the end of the sequence and commenting the results teachers wrote:

"*On the main purpose of calculating the actual size of an object using a scale, progress on issues 7 and 8 are encouraging, it shows that the proposed remediation allowed a better understanding of the computing method. Putting into practice during the session 2 of science confirms this impression: in practice, the students were able to correctly use the scale by measuring the segment and then assigning it the right size, which could suggest that they understood that the scale was represented by the segment and the length given with a unit but we have seen that actually the scale was represented only by the segment. For question 4, it is interesting to notice that for both groups, the number of right answers is decreasing, with a significant decline. We believe that we have too much insisted on the segment below the number that they may have retained only the scale corresponding to this segment. Our remediation was to break down into micro-tasks the understanding of a scale, we see here that this can cause misunderstandings.*"

4. References

"Je lève la main" for clickers:

http://www.speechi.net/fr/index.php/home/evaluer/boitier-de-vote-interactif/

https://www.jelevelamain.fr/en/

The software "Optikos":

http://www.sciences-edu.net/physique/optikos/optikos.htm

For further information (in French):

https://ife.ens-lyon.fr/fasmed/spip.php?rubrique25