Chapter 1

Watersheds

In association with Françoise Chauvet, Philippe Colin, Colette Hirn-Chaine and Wanda Kaminski.

1. HOW AND WHAT TO SPOTLIGHT

Granted, "Physics is physics," Newton's laws and their applications are not about to be put into doubt, nor are the Snell-Descartes laws likely to be questioned in geometrical optics, although their origin might be, depending on what country you happen to be in[1]. But deciding that these laws have to be taught at school does not determine the content of teaching. A mountain is a mountain, but a thousand different lights may fall upon it, and it can be photographed from different angles, using different grains of film... Over the past twenty years, the idea that this applies to the content of teaching has been gaining ground among the planners of school syllabuses in France and other countries. The possibilities it opens up in teaching practice are so numerous, however, and their range is so much greater than one might think, that it is worth giving them serious consideration.

Using "spotlights" on the mountain, so to speak, means one doesn't have to cut it up into slices – teaching objectives need not be determined by a single "level of difficulty". In France, researchers often speak in terms of "didactic transposition"[2] when scientific knowledge is used to build

[1] The laws of reflection and refraction are known as "Descartes' laws" in France, but elsewhere, the law of refraction is called "Snell's law", since the Dutch astronomer and mathematician was the first to discover it in 1620.

[2] Chevallard (1965) applied this concept to the teaching of mathematics.

"knowledge to be taught", i.e. what one wants to teach a given public[3]. The image of the spotlight serves our purposes, however. If it brings to mind a theatrical production, so much the better: in teaching, as in drama, "what" and "how" are one. The director of a play will emphasise what lies at the heart of a text, and it is useful to recognise that the "how" of teaching practice is the message itself, not just a more or less effective means of transmitting a message.

We have, of course, had to organise the descriptions of the teaching proposals contained here, and always begin by specifying what content-matter is to be taught, and where stress is to be laid. Nevertheless, all of the aspects of teaching practice discussed here play a very real part in defining the content-matter of what is taught.

In fact, the content and objectives listed in school syllabuses leaves many choices open. Let's take the case of elementary geometrical optics.

1.1 Optics in junior high school: the syllabus

A new Physics syllabus was established in France in 1985, for *Quatrième*[4], which was then the third year of physics education. For Geometrical Optics, the following points were listed:

- *a few sources and receptors of light*
- *the rectilinear propagation of light: the pinhole camera, a model of the ray of light*
- *real shadows: the various phases of the moon*
- *cast shadows: eclipses*
- *the speed of light in a vacuum*

The "practical and theoretical" learning objectives were:

Distinguishing between different sources: objects that are luminous in themselves and objects that diffuse light.

Silver chloride darkens when exposed to light; how this applies to photographic film.

The direction of the propagation of light.

Building a pinhole camera.

Representing a beam and a ray of light.

Explaining the phases of the moon and eclipses.

The speed of light: light years, astronomical quantities.

[3] This expression "didactic transposition" may, depending on the different authors, mean the set of rules involved when the "knowledge to be taught" is decided - this is the original acceptation - or, more vaguely, the end product of the decision making process.

[4] In France, the eighth year of schooling, i.e. the third year of secondary schooling.

These points are followed half a page of comments in all.

Another paragraph deals with the spectral analysis of light and some concepts used in of astrophysics. It is specified that at the next grade level, *Troisième*, pupils will study lenses and the real images that can be formed with converging lenses (on a screen) for a real object, with foci, focal distances, optical imaging, and construction rays.

1.2 What else *is* there to do?

Let's consider the introduction to optics, as it is described above, anyway. What sort of choices need to be made at this level?

Sources: of course! Light: Obviously! Rectilinear propagation: where would we be without it? The pinhole camera: it's such an easy experiment, why not? Shadows: they're common to daily life and astrophysics, besides, they're the simplest phenomenon, really. Etc...

In 1992, another syllabus was established for the same grade level[5], *Quatrième*. By that time it was once again, temporarily, the first grade in which physics was taught. The official text is much more detailed than in 1985, it provides "back-up activities" for the content-matter, specifies the "competences mastered, or being mastered", and comments. There is also an "accompanying document", with approximately 20 pages on the Optics syllabus. As in 1985, some major objectives for teaching science at this level are stated. Roughly speaking, these objectives are similar in both texts (some excerpts are given in Appendix 1)[6]: namely, to train future scientists, but also to reach other pupils, and give them an idea of what science is; the experimental approach and rigorousness are key words.

The contents fall under four headings. What are they?

Sources of light, the rectilinear propagation of light, vision, and the principle of image formation. Of course, right from the first paragraph one finds primary and secondary sources, diffusion, stars and planets, and of course the speed of light; the second mentions shadows, the phases of the moon and eclipses, and the fourth deals with the correspondence between a real object and a real image produced by a converging lens. Nothing very new about that, except that a new paragraph entitled "vision" has been added to the others – but even in 1985 this was taken into consideration: in eclipses, with the visibility of stars and planets. And teachers had also been warned against the idea that a ray of light leaves the eye to seek out visual

[5] Reference: Ministère de l'Education Nationale 1992.

[6] See in Appendix 1 some excerpts of preambles for official syllabuses in France (1985, 1992, 1999), and for an English project, Advancing Physics AS (IOP 2000), resp. J. Ogborn, former responsible for the Nuffield project.

http://www.springer.com/978-1-4020-1276-1

Teaching Physics
Viennot, L.
2003, XV, 235 p., Softcover
ISBN: 978-1-4020-1276-1