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After the Abbé Nollet, the Teaching of Physics in “Lycées” in France

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Abstract: Abbé Nollet is known as the first professor of experimental physics in France in the 18th century. However, at that time, some technical school provided already an excellent technical education. But physics teaching in general education really took shape after the revolution and with the creation of the l*ycées* by Napoleon. Curricula were then published, along with lists of equipment to be used in the *lycées.* This administrative organization still exists in France. The *Ecole Normale de l’an III* was responsible, during four months, for training teachers for these new establishments. Professors were the greatest scientists of that time. The mineralogist René-Just Haüy was commissioned to write the first physics textbook. During this period all the *grandes écoles* were created. At the same time, in 1808, the *baccalauréat* and the *agrégation* were introduced. However, it was not only at the middle of the 19th century that a scientific curriculum was created, separated from that of the humanities. Also, during this period, the scientific *baccalauréat* becomes compulsory for medical studies. However, it was not before 1880 that Camille Sée created *lycées* for girls. With the development of printing, many of the teachers published their lectures in textbooks for their students. Together with the official texts, these books and the collections of apparatus preserved in historical high schools provide us with information on the physics taught in the 19th century.

Keywords: Teaching, Physics, France 19th century

1. Introduction

Nobody can understand the scientific teaching in France without knowing the various French administrative structures during the 19th century and the importance of *l’Ecole de l’an III.* Together with the official texts, textbooks and collections of apparatus preserved in historical high schools provide us information on the physics taught in the 19th century. Two debates occupied this century:

- the place of the physical sciences in general secondary education
- the relationship between mathematics and physics

2. The situation at the end of 18th century

In the mid-18th century, the well-known abbé Nollet popularised experimental physics. So that, in 1752, a chair of experimental physics was created for him at the *college de Navarre* in Paris. He did experiments like shows, mainly for the Parisian high society and few students in some other cities.

At that time, Physics was taught mainly in Jesuit colleges, which were the most opened to new scientific ideas. This teaching, always in Latin, took place at the end of the cycle, as part of philosophy courses and very much influenced by scholasticism. Nevertheless, Jesuits set up cabinets equipped with the most recent scientific tools. However, in 1763, the Jesuits were excluded from France and their colleges closed or given to other religious society not so influenced by the new ideas. After 1770, French replaced Latin in study, excepted for medicine courses.

On the other hand, mathematics played an increasingly important role. It was used as a selection tool for military or naval officers, mainly from the nobility, for whom important scientific high schools were founded. For example, the *École royale du Génie de Mézières* where Monge and Borda were students in 1767. But, though Etienne Bezout wrote a *Cours complet de mathématiques à l'usage de la marine et de l'artillerie*, mathematics was not applied to physics.

However, scientists and politics were aware of the poor situation of the science teaching in France. For example, in the Encyclopedie's college article d'Alembert was very critic. "Enfin dans la Physique on bâtit à sa mode un système du monde; on y explique tout, ou presque tout; on y suit ou on y réfute à tort & à travers Aristote, Descartes, & Newton" (d'Alembert 1753, p. 635).

3. The French revolution and its consequences

3.1 The Condorcet's report

The French revolution will speed things up. During this period, an administrative reorganisation occurred, France was divided into departments, and an *Ecole Centrale* was created in each department for the secondary teaching. On 7 *vendémiaire* an III (28 september 1794), was founded the *Ecole Centrale des Travaux Publics (*later *École Polytechnique*). The curriculum written by Gaspard Monge was essentially based on mathematics and will influence the scientific teaching during the following centuries.

In April 1792**,** Condorcet presented to the *Assemblée Législative* a project for the organisation of public education with a large place devoted to sciences (Fig. 1, left). He wrote:

> Plusieurs motifs ont déterminé l'espèce de préférence accordées aux sciences mathématiques et physiques. D'abord, pour les hommes qui ne se dévouent point à de longues méditations, qui n'approfondissent aucun genre de connaissances, l'étude, même élémentaire, de ces sciences est le moyen le plus sur de développer leurs facultés intellectuelles, de leur apprendre à raisonner juste, à bien analyser leurs idées. [...]. C'est que dans les sciences naturelles, les idées sont plus simples, plus rigoureusement circonscrites; c'est que la langue en est plus parfaite, que les mêmes mots y expriment plus exactement les mêmes idées. [...]. Il n'est pas d'enfant, s'il n'est absolument stupide, qui ne puisse acquérir quelque habitude d'application, par des leçons élémentaires d'histoire naturelle ou d'agriculture. Ces sciences sont contre les préjugés, contre la petitesse d'esprit, un remède sinon plus sûr, du moins plus universel que la philosophie même. Elles sont utiles dans toutes les professions; et il est aisé de voir combien elles le seraient d'avantage , si elles étaient plus uniformément répandues. [...] les progrès des sciences physiques doivent produire une heureuse révolution dans les arts; et le plus sûr moyen d'accélérer cette révolution est de répandre ces connaissances dans toutes les classes de la société, de leur faciliter les moyens de les acquérir[1] (Belhoste 1995, pp. 67-69).

The *Ecole Centrale* did not strictly apply the Condorcet's report, but some of its ideas have been retained and each school must have a physics and chemistry teacher and a cabinet of physics instruments. But

[1] All the translations have been done by the author.
First, for those who are not prone to long pondering, to furthering any kind of knowledge, even an elementary study of those sciences is the surest way to develop their intellectual faculties, to learn to reason right and to analyze their ideas well. […] That is because in the natural sciences ideas are simpler, more rigorously circumscribed; because their language is more perfect, and the same words convey more exactly the same ideas. […] There is not a child, unless he is a complete idiot, who cannot gain some habit of rigour from elementary lessons in natural history or agriculture. Those sciences are a more universal if not surer remedy against prejudice, against narrow-mindedness, even than philosophy. They are useful to all trades; and it is easy to see how even more useful they would be if they were more widespread. […] the progress in physical sciences must beget a fortunate revolution in the arts: and the surest way to accelerate this revolution is to spread that knowledge to all the social classes and to facilitate their acquiring.

during the first part of 19th century the general teaching remained always classical, based on a solid study of Latin and literature. It concerns the children of the educated bourgeoisie and had no professional objective. Hence special schools for technical education were created but they did not provide access to the *baccalaureat* and university.


RAPPORT
ET
PROJET DE DÉCRET
Sur l'organisation générale de l'instruction publique,
PRÉSENTÉS
A L'ASSEMBLÉE NATIONALE,
AU NOM DU COMITÉ D'INSTRUCTION PUBLIQUE;
PAR M. CONDORCET, Député du Département de Paris:
Les 20 & 21 Avril 1792 l'an 4e. de la liberté,
Imprimés par ordre de l'Assemblée Nationale.
A PARIS,
DE L'IMPRIMERIE NATIONALE.
1792.
Instruction publique. N°. 5.


SÉANCES
DES ÉCOLES NORMALES,
PAR DES STÉNOGRAPHES,
PAR LES PROFESSEURS.
ARRÊTÉ

Fig. 1, left: D'Alembert's report; **right:** Ecole An III report. (Source: gallica.bnf.fr / BnF)

3.2 The Ecole Normale de l'an III

With the creation of *Ecoles Centrales*, a lack of teachers occurred. So, the *Ecole Normale de l'an III* was missioned to train teachers quickly. This school took place, in Paris, during 4 months, from *1er pluviose de l'an III* (20 January 1795) to *30 floréal de l'an III* (19 May 1795). 1500 students came from the whole France, then had to return to their own city and open an *Ecole Normale*, where they had to pass on what they have learned.

Their professors were well known: Mathematics: Joseph-Louis Lagrange et Pierre-Simon Laplace; descriptive geometry: Gaspard Monge; Physics: René Just Haüy; Natural sciences: Louis Jean-Marie Daubenton; Chemistry: Claude Louis Berthollet.

Teaching consisted in 15 lessons and 10 debates; experiments were also carried out such as Newton's tube or Magdebourg hemispheres. It is worth noting that the entire 8th debate was devoted to Atwood's machine. The teacher also answered to questions from the audience and to questions sent by post from far away, for example from St Gaudens, a city near the Pyrénées. All the debates were immediately printed. (Fig. 1, right). As noted by Etienne Guyon, Haüy thus asserted the need of using mathematics in physics but delivered an essentially descriptive course without any recourse to mathematical formalism or any explicit use of the mathematics lessons given at the same time. He used experiments to confirm the theory rather than making a show (Guyon 2006).

3.3 Napoleon's reorganisation of teaching

The most important administrative organisation was settled in 1802 (11 floréal an X) under the government of Napoleon Bonaparte. It still exists in France.

In the secondary level, *lycées* replaced *écoles centrales* but even if their names change several times depending on the political regime, the administrative organisation remained the same.

Then, in 1808, Napoléon I organised the Université: the baccalauréat, the agrégation and the inspector's position were introduced. Nowadays, according to the French law, the *baccalauréat* is still the first academic degree and the *agrégation* remains a competitive examination for civil service in the French public education system.

A commission including Laplace, Monge and Lacroix wrote, in 1802 (11 floréal an X), the first national curriculum and gave a list of the books to be used for teaching. We note that all the members of this commission were mathematicians and no physicists.

Table 1 summarizes the study plan, indicating the books prescribed by the commission (in italic). We see several books for mathematics but only one for physics (from Haüy).

Table 1: Study plan 1802

1stYear	2nd Year	3rd Year	4thYear	5th Year	6th Year
latin	latin	latin	litterature latin /french	litterature latin /french	latin
	maths arithmetic *Lacroix, Bezout, Bossut* little physics first part *Haüy*	maths geometry *Lacroix, Legendre* astronomy *Biot*	maths algebra *Lacroix, Biot* chemistry *Adet, Lavoisier, Berthollet*	integral maths *Lacroix, Lagrange*	maths differential equation *Lacroix* mechanics *Francoeur Fischer* high physics second part *Haüy*

There will be many other changes all over the first part of the century. For example, since 1826, all the physics teachings were gathered during the two last years only.

3.4 The Haüy's textbook

As the last edition of the Polinière's textbook was in 1733, Haüy was designed to write the first physics textbook. "La commission n'ayant pas trouvé de livres propres à l'enseignement des sciences physiques dans les lycées propose [...] d'inviter le citoyen Haüy à écrire les Traités de physique; et si ce savant ne pouvait s'en charger, le citoyen Biot serait indiqué pour faire ce travail"[2] (Belhoste 1995, p. 81).

The table of contents of Haüy's treatise included a first part with general properties of bodies, attraction, heat, water, air and a second part with electricity, magnetism and light. The first part was directly a copy of the an III lessons, since Haüy explained that he had to write the book very quickly and noted that: "Les Maîtres habiles qui l'auront entre les mains, plus faits que personne pour sentir la difficulté d'un pareil travail, le jugeront d'une part avec moins de sévérité, suppléeront de l'autre à ce qui pourrait y manquer" (Haüy 1803).[3] As an example, Haüy explained the new system of units and how to determine the new kilogramme but in his book, he still used the old units. This book contained engraved sheets with pictures essentially devoted to geometrical crystal structures or geometrical optics, but without any algebraic formulae.

3.5 Equipment and books

Haüy did not give any instruction about the equipment of the *lycées*. It was only in 1821 that a list of devices to buy (when having enough money) was given (Fig.2).

[2] The commission, having not found any suitable book for teaching the physical sciences in high schools, proposed to invite citizen Haüy to write the Treatises of Physics; and if this scientist is unable to undertake the task, citizen Biot would be proposed to do it.
[3] The skilled masters who will have this book in hands, will be able to complete it.

Principales machines pour le cours de physique des collèges royaux

	en francs
Machine d'Atwood (*Pixii*)	650
Balance, servant de balance hydrostatique (*Pixii*)	240
Petite machine de Fortin à diviser le verre	100
Machine pneumatique avec ses récipients (*Pixii*)	500
Machine pneumatique de compression	500
Un mètre en cuivre (*Lenoir*)	"
Compas à mesurer les diamètres et autres longueurs (*Fortin*)	"
Tube pour la chute dans le vide (*Pixii*)	40
Ballon à peser l'air (*Fortin*)	36
Baromètre (*Richer*)	60
Tube de Mariotte (*Frécot*)	12
Deux modèles de pompes	200
Fontaine de compression, servant de chalumeau et d'appareil pour les eaux gazeuses (*Pixii*)	160
Fontaine intermittente (*Pixii*)	40
Aréomètre à pompe (*Pixii*)	60
Aréomètre de Nicholson (*Pixii*)	15
Niveau (*Fortin*)	24
Fontaine de Héron en verre (*Pixii*)	25
Double baromètre dans un récipient (*Pixii*)	30
Quatre thermomètres (*Frécot*) à 3 F	12
Thermomètre de Leslie (*Frécot*)	12
Appareil pour la dilatation des solides (*Pixii*)	50
Petit modèle de pendule compensateur (*Pixii*)	20
Deux miroirs (*Pixii*)	150
Cube à face de différents métaux (*Pixii*)	60
Cube à faces peintes (*Pixii*)	10
Appareil pour montrer l'inégale conductibilité (*Pixii*)	25
Appareil pour le *maximum* de densité de l'eau (*Pixii*)	10
Appareil pour le mélange des vapeurs avec les gaz (*Fortin*)	120
Hygromètre à cheveu (*Fortin* ou *Richer*)	100
Appareil pour déterminer les quantités de chaleur dégagés dans la combustion (*Pixii*)	120

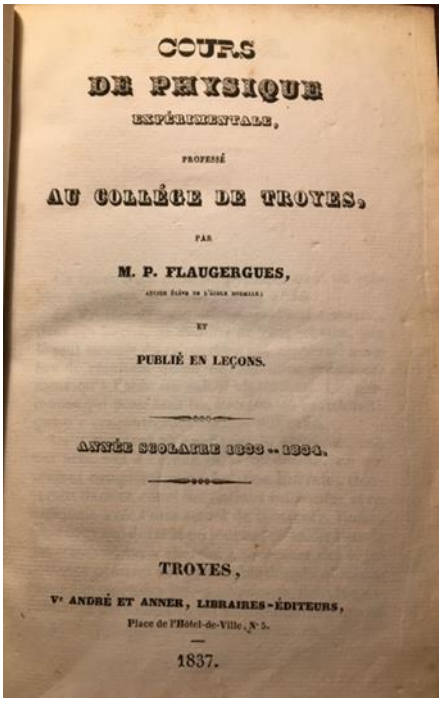
Fig. 2. The equipment of the lycée in 1821 (Belhoste 1995, p. 99).

These devices are a part of the heritage collections of historic *lycées* in Paris and major cities, for example lycée Guez de Balzac (Angoulème) (Fig. 3, left) or lycée Ampère (Lyon) (Fig.3, right).

Fig. 3, left: Lycée Guez de Balzac ; **right:** Lycée Ampère Lyon.

Concerning books, during the first part of the 19th century, some others existed apart the official Haüy's one. They give ideas of the different opinions and situations. For example, already in 1804, Pierre Jacotot published his treatise in Paris and sold it, in Dijon, 12 francs which was equivalent to 4 days of a worker's salary (Jacotot 1804). The lessons of Pierre Flaugergues were printed in Troyes at the expense of its students (Flaugergues 1837) (Fig. 4).

Depretz and Biot are more known authors. Biot who was also selected to write the first official book had a real different point of view concerning the mathematics.[4] “Ce n’est pas toutefois sans quelques regrets que je me suis résolu à présenter aux élèves un ouvrage où la physique est dépouillée de ce qui fait sa principale utilité et sa certitude, je veux dire les expressions et les méthodes mathématiques” (Biot 1824, p. vi). For their part Depretz and Jacotot didn’t hesitate to use clearly algebraic formulae.


COURS
DE PHYSIQUE
EXPÉRIMENTALE,
PROFESSÉ
AU COLLÉGE DE TROYES,
PAR
M. P. FLAUGERGUES,
ET
PUBLIÉ EN LEÇONS.
TROYES,
Vᵉ ANDRÉ ET ANNER, LIBRAIRES-ÉDITEURS,
Place de l'Hôtel-de-Ville, N° 5.
1837.

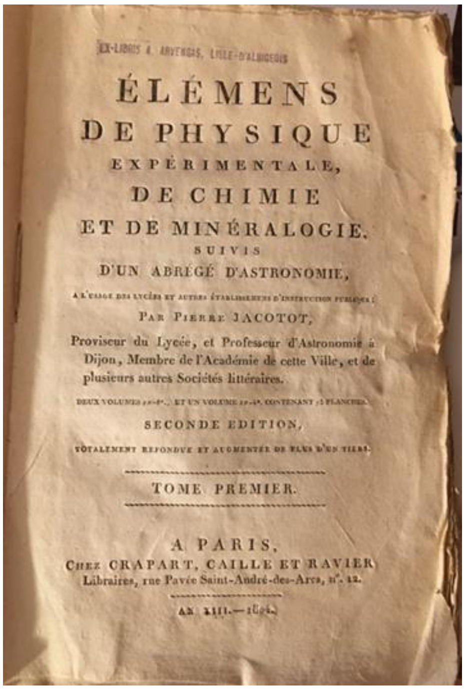

ÉLÉMENS
DE PHYSIQUE
EXPÉRIMENTALE,
DE CHIMIE
ET DE MINÉRALOGIE.
SUIVIS
D'UN ABRÉGÉ D'ASTRONOMIE,
PAR PIERRE JACOTOT,
Proviseur du Lycée, et Professeur d'Astronomie à Dijon, Membre de l'Académie de cette Ville, et de plusieurs autres Sociétés littéraires.
SECONDE EDITION,
TOME PREMIER.
A PARIS,
CHEZ CRAPART, CAILLE ET RAVIER,
Libraires, rue Pavée Saint-André-des-Arcs, n°. 12.

Fig. 4, left: Flaugergues’s textbook; **right:** Jacotot’s texbook

All these books contained pictures on large, engraved sheets which were not easy to use. For example, in the Depretz’ book it is difficult to see that the pipes on the left are to be used with the organ on the right and the snow crystal have nothing to do here (Fig. 5).

3.6 The reality

In fact, in the little towns, the situation was not very satisfying. We can have an idea with the letters sent by Adolphe Ganot to the minister from his college Bourbon-Vendée at La Roche-sur-Yon.

> J’obtins à la fin de 1829, la chaire de mathématiques du collège de Bourbon Vendée cet établissement mérite, il est vrai, d’être mis au rang des premiers collèges […] par les bourses dont il est doté, mais sans livres, sans laboratoire dans une des moindres villes de France il ne m’offrait aucune ressource pour parvenir à l’agrégation (Ganot 1834).[5]

The *baccalauréat* took also an important place because it was impossible to attempt University without *baccalauréat-ès-lettres*. Created in 1808, *baccalauréat-ès-sciences* was clearly dependent on *baccalauréat-ès-lettres*. Nobody will be awarded a bachelor’s degree in the faculty of sciences until he has obtained the same degree in the faculty of literature, and until he has answered questions on

[4] It is not without some regret that I have decided to present to pupils a work in which physics is stripped of that which makes it most useful and certain, that is to say mathematical expressions and methods.

[5] At the end of 1829, I obtained the chair of mathematics at the Collège de Bourbon-Vendée, an establishment which, it is true, deserves to be ranked among the top colleges in France [...]; but with no books and no laboratory in one of the smallest towns in France.

arithmetics, geometry, trigonometry, algebra and its application to geometry (Sonnet, Saiget & Delafosse 1846, p. X).There was no Physics, consequently the *baccalauréat-ès-sciences* attracted little interest because it was only required to become a simple teacher since there was no physics at entry in the *Polytechnique* school.

For example, in 1812: 24 diploma *ès-sciences* vs 1632 *ès-lettres* had been delivered.

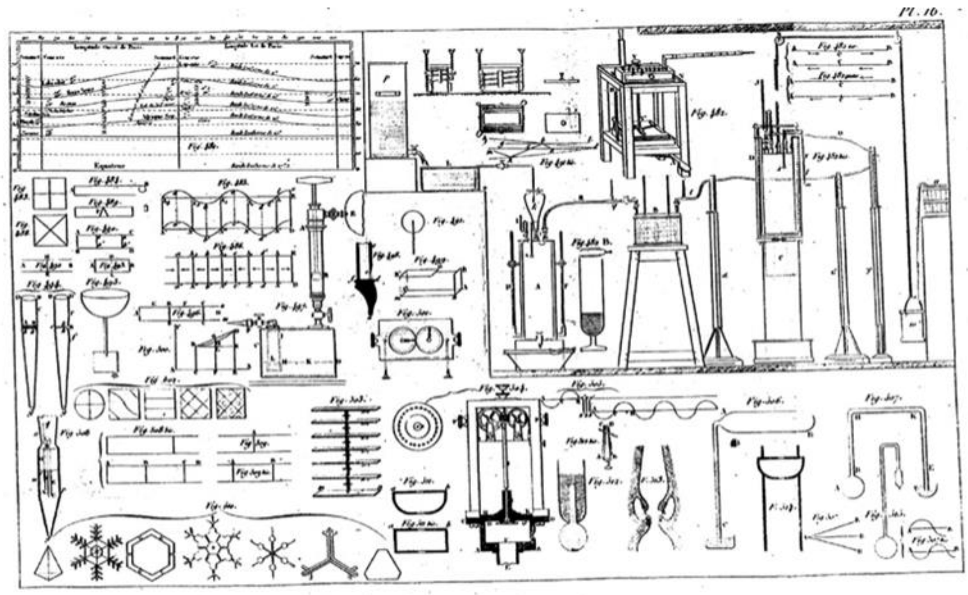


Fig. 5. Copperplate 16 in Depretz' book

4. The bifurcation

4.1 A new organisation

As Nicole Hulin has clearly shown, throughout the first half of the 19th century, there were many debates in favour of teaching together humanities and sciences or introducing two different options; thus, the place of physics teaching often changed (Hulin-Jung 1989).

Several important scientists such as Jean Baptiste Dumas, claimed for more science already at the secondary level. Conceived by Fortoul, the *bifurcation* (1852) established a common secondary curriculum for the younger students in the lycées (up to and including the 4º); thereafter, it imposed a choice between a predominantly literary curriculum, based on study of the ancient languages and literature, and another one that stressed scientific and modern subjects.

The 1852 syllabus did not change very much for physics; it remained experimental and the only change was the introduction of mechanics in physics. However, the *baccalaureat es science* still included a written Latin version.

Moreover, big criticisms appeared in official reports, such as, in 1863, without mathematics, you can only produce physics of poor quality. In 1854, the use of instruments was also discussed. The report mentions, on the one hand, that the huge price of apparatus leads students to think that physics should be reserved to rich people bearing a largely equipped cabinet and on the other hand that the professors don't take the risk to teach a class of phenomena when an apparatus, often devised by Parisian builders, is missing from their cabinet.

Finally, this reform did not succeed but in 1866, in addition to traditional teaching, a new one is created: *l'enseignement secondaire special* which was without latin and gave an important place to science and its applications.

The students can leave this teaching after the first three years. Concerning physics, the teacher must not forget that all algebraic formulae must be banned and that teaching must be purely experimental.

At that time also**,** the Falloux's Laws allowed schools outside the supervision of the University. They created a mixed system, with public (mostly secular) schools and private ones (mostly catholic). In 1867**,** Victor Duruy also proposed the creation of a secondary education for girls. The law was signed by Camille See in 1880 and became effective in 1882. Obviously, the curriculum without Latin was different than that for boys, (until 1924) and was much lighter in science.

4.2 New textbooks

The Bifurcation and the Falloux's law coincided with a great development of printing, thanks to growing industrial paper. Then many textbooks were published for the *Baccalauréat* and the preparation to high schools, such as *École Polytechnique.* These books covered all the physics taught at the *Baccalauréat* level. The authors were numerous, the professors published their courses as we write documents for our students. Apart from Adolphe Ganot, the authors of the textbooks were former students of the *École Normale Supérieure*, who became teachers in the major *lycées* or inspectors.

Thanks to Falloux's law, Ganot taught in a private school, in Paris without *agrégation.* We don't know if it was the reason why Ganot decides to include many pictures in his book. For this purpose he introduced, in physics textbooks, a new technic for the pictures: he used the wood's end grain while the older technique employing the softer side grain or copperplates. It allows more detailed images and wood-engraved blocks could be used on conventional printing press. Moreover, text and images were gathered on the same page (Fig. 6). With such technics for pictures, Ganot was able to show the apparatus exactly. So, if the school didn't have this object, it was not so important. This book was a great success, 255 500 treatises were sold in 30 years and abbé Moigno wrote:

> Ce qui distingue ce nouveau traité élémentaire et le place au premier rang, ce sont les illustrations dont chaque page est enrichie. […] Dans le livre de M. Ganot, les figures ne sont point la reproduction éternelle des vieux dessins qui remontent à l'époque de l'abbé Nollet, de Sigaud de Lafond, de Brisson, souvent même aux temps primitifs[6] (Moigno 1853, p. 644).

Successive editions of Ganot's textbook constitute an invaluable corpus for studying the evolution of teaching in relation with scientific and social developments. Each edition stated that it has been 'augmented with new engravings and the most recent works on the various branches of physics'. Thus, we went from an edition in 1866 with a 'Caloric' section to the 1872 edition where the same section became 'Heat' with a paragraph entitled History of the dynamic theory of heat.

Technical innovations were added as they became available and were described in detail on the front page. Ganot wrote a book with few mathematics but many practical applications: for example, home heating**,** telephone, telegraph, lightning conductor, microscope.

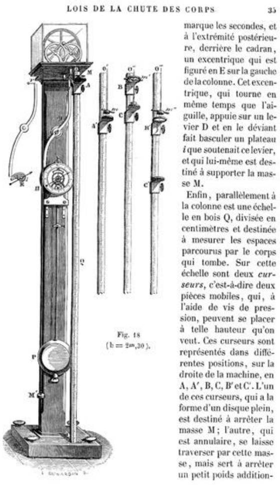
All the authors quickly copied the Ganot's book. Louis Figuier wrote in the newspaper *La Presse* the 23 March 1862:

> La librairie parisienne entreprend une rude guerre contre le traité de physique en faveur depuis plusieurs années dans les lycées et les écoles, c'est à dire le traité de physique de M. Ganot si connu de notre jeune génération. M. Victor Masson d'une part, M. Dunod d'autre part, viennent de lancer […] deux traités élémentaires de physique qui vont faire singulièrement pâlir le livre de M. Ganot.

[6] What sets this new treatise a part and places it at the fore front are the illustrations on every page. […] In Ganot's book, the figures are not eternal reproductions of the old drawings dating back to the time of Abbé Nollet, Sigaud de Lafond, Brisson, and often even to primitive times.

Chacun de ces deux ouvrages émane de professeurs de l'Université. MM. Drion et Fernet sont les auteurs du traité de physique élémentaire publié par M. Victor Masson, MM. Boutan et Ch. D'Almeida ont rédigé le cours élémentaire de physique publié par M. Dunod. C'est assez dire que la composition de ces livres doit parfaitement répondre au programme des études universitaires, qu'elle doit être mesurée, et, pour ainsi dire, calquée sur les besoins de l'enseignement particulier des lycées ou des écoles professionnelles.[7]

These books used the same pictures as the Ganot's one and didn't use much more mathematics. In 1884**,** when the Ganot' book was taken over by Hachette and revised by Maneuvrier, who strongly mathematized it (Ganot Maneuvrier, 1882). Ganot complains that there are too many mathematical formulae, which is intended above all for students, who have little love of mathematics but who should be spared, since it is that has made the book's fortune.


LOIS DE LA CHUTE DES CORPS 35

marque les secondes, et à l'extrémité postérieure, derrière le cadran, un excentrique qui est figuré en E sur la gauche de la colonne. Cet excentrique, qui tourne en même temps que l'aiguille, appuie sur un levier D et en le déviant fait basculer un plateau *i* que soutenait ce levier, et qui lui-même est destiné à supporter la masse M.

Enfin, parallèlement à la colonne est une échelle en bois Q, divisée en centimètres et destinée à mesurer les espaces parcourus par le corps qui tombe. Sur cette échelle sont deux *curseurs*, c'est-à-dire deux pièces mobiles, qui, à l'aide de vis de pression, peuvent se placer à telle hauteur qu'on veut. Ces curseurs sont représentés dans différentes positions, sur la droite de la machine, en A, A', B, C, B' et C'. L'un de ces curseurs, qui a la forme d'un disque plein, est destiné à arrêter la masse M; l'autre, qui est annulaire, se laisse traverser par cette masse, mais sert à arrêter un petit poids addition-

Fig. 18 (h = 2m,30).


Fig. 124. — Soufflerie.

Fig. 6, left: the Atwood's machine (Ganot 1855)**; right:** the organ (Ganot 1859)

5. 1902, a real change

Finally, the big change took place in 1902 with a big reform that introduce lab work for the students. The official instruction indicates:

Le professeur se contentera d'exposer les faits tels que nous les comprenons aujourd hui sans se préoccuper de l'ordre historique.On lui demande de débarrasser l'enseignement de beaucoup de vieilleries que la tradition y a conservées: appareils surannés, théories sans intérêt , calculs sans réalités. Il n'entrera point dans la description minutieuse des appareils ni des modes opératoires […] Evitant les développements mathématiques, il doit toujours être fondé sur des expériences, mais pour ses démonstrations expérimentales, le professeur emploiera le moins possible des appareils spéciaux ; il cherchera à les réaliser avec les moyens les plus simples et les plus a portée, s'attachant bien plus à

[7] Parisian bookshops were waging a fierce war against the physics treatises that have been popular for several years in lycées and schools, i.e. the physics treatise by Mr Ganot so well known to our younger generation. Mr Victor Masson on one hand, and Mr Dunod on the other, have just launched almost one after the other […] two elementary physics treatises which will make Mr Ganot's book pale in comparison. Each of these two works was written by university professors. Mrs Drion and Fernet were the authors of *Traité de physique élémentaire,* published by Victor Masson; Mrs Boutan and Ch. d'Almeida wrote *Cours élémentaire de physique*, published by Dunod. It is enough to say that the composition of these books must correspond perfectly to the university syllabus.

> l'esprit des méthodes qu'aux détails techniques d'exécution; il utilisera fréquemment les représentations graphiques , non seulement pour mieux montrer aux élèves l'allure des phénomènes, mais pour faire pénétrer dans leur esprit les idées si importante de fonction de continuité;enfin par des applications numériques toujours empruntées à la réalité et réduites aux formes les plus simples, il habituera les élèves à se rendre compte de l'ordre de grandeur des phénomènes et à discerner dans quelles limites de précision une même correction peut être nécessaire ou absurde[8] (Belhoste 1995, p. 600).

In conclusion we can say that, in France, during the 19th century, the teaching at secondary level was still a classical teaching where the science was not important. The *baccalauréat es lettres* was always compulsory for studying at the University and the scientists was trained at the *école polytechnique*, with focused on mathematics.

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[8] The teacher will be content with setting out the facts as we understand them today without worrying about the historical order. He will be asked to rid of teaching of a lot of the old things that tradition has preserved: outdated apparatus, uninteresting theories, calculations that have no reality. […] Avoiding mathematical developments, it must always be based on experiments. Paying much more attention to the spirit of the methods than to the technical details of execution; he will make frequent use of graphical representations, not only to show to the pupils the course of the phenomena, but also to instil in their minds the very important idea of the continuity function; finally, by numerical applications which are always borrowed from reality and reduced to the simplest forms, he will accustom the pupils to realise the order of magnitude of the phenomena and to discern within what limits of precision the same correction may be necessary or absurd.