

ISSUES RELATED TO THE TEACHING OF MATHEMATICS AT THE "STUDIO PADOVANO" IN MID-1800S

Giuseppe CANEPA

I. T. I. Galileo Galilei, Genova

canepa.giuseppe@ecg-genova.edu.it

ABSTRACT

The developments in mathematics in the decades around mid-19th century led some professors of mathematics and science from the University of Padua to ask themselves significant questions about the teaching and learning methods of their disciplines. The scholars of the “Studio Padovano”, name of the faculty of philosophy and mathematics at the University of Padua, to which we will refer, are: Giovanni Santini, Giusto Bellavitis, Domenico Turazza, and some others. They worked on developing ideas and hypotheses on a new legislation related to teaching and on finding the most appropriate ways to influence decisions about those matters at the institutional level. They also worked on drafting educational projects for original approaches to their teaching subjects and their actual implementation during lectures with students. From the pedagogical-educational point of view, the steps to obtain a good transmission of knowledge to the new generations were the subject of a debate (through an exchange of correspondence) and also were the motivation for the production of appropriate publications on the subject. The analysis of this material, still partly handwritten and unpublished, illustrates a complex moment in which these scholars already acted as if they belonged to the very same state, although still under the Austro-Hungarian legislative sphere. The study of this material can also provide interesting points of comparison with the problems that characterized the scientific activities of subsequent periods.

Introduction

This talk refers to a set of historical materials and its intention is to offer insights that could be useful for teacher education and cultural enrichment (Boro&Guala, 2008). The material that has led us to an in-depth study, related to these issues, comes from a long historical tradition. It represents both an interesting reference for teacher training and an input for a more articulated conception of teacher’s role within educational institutions.

In the material presented, historical and educational issues of the 19th century are linked to highlight aspects that are still very relevant today: The views of the three mathematicians examined present interesting observations and explicit comments related to their teaching practice. All of this clearly

resonates with today's issues and meanings. The material can therefore be a useful comparison gymnasium for today's teachers; for example, for the following content: studies on the level of abstraction of the content of the subjects taught with reference to the age of the children; the teacher's choice of whether to propose topics to the pupil in a synthetic or analytical manner, whether to start from the particular or the general, whether from practical problems to arrive at theoretical abstraction or vice versa.

1 The protagonists and their teaching texts

The development of the University of Padua is closely related to that of the Astronomical Observatory, the Istituto Veneto di Scienze, Lettere e Arti, and the Accademia Patavina di Scienze Lettere e Arti. Simultaneously these active institutions lived off the work of the same protagonists who exchanged roles and assignments within the various structures. A number of texts, including recent ones, have been published on the subject (Borgato&Pepe, 2011; Casallato&Pigatto, 1996), and there is a considerable number of manuscripts rich in information in: the Bellavitis Fund of the Istituto Veneto di Scienze, Lettere e Arti, Venice; "Cassetta Loria", Genoa University Library; "Istituto Mazziniano", Genoa; other Libraries in Piacenza, Naples, Bologna. A detailed study of the texts in adoption by the following professors: G. Santini, C. Conti, P. Maggi, S. R. Minich, D. Turazza, G. Bellavitis, showed a gradual transition from texts by other universities to handwritten handouts of the professors to end with texts published by the professors themselves, rich in topics that took into account European developments in mathematics and science.

The three figures, interesting for their sensitivity and study on teaching, that we take into consideration in this paper are: Giovanni Santini, Domenico Turazza, and Giusto Bellavitis.

They all owed a lot to Santini (1787-1877) who transferred to them the style of teaching, esteem and trust with the students. He was also a rare school leader for all of them because of his style in writing treatises for study. Santini had been student in Pisa and at the Brera observatory from 1806, he became Rector of the University of Padua twice. He was a member of 21 academies, both Italian and foreign and published works, mainly on astronomy, known and praised throughout Europe. The work we are interested in, highly praised when it appeared and still an example of scientific literature, is *Elementi di*

Astronomia (Elements of Astronomy) (Santini, 1819). The first edition dates 1819, the second is from 1830, and was conceived by Santini when he was given the chair of astronomy. He wrote:

I meditated for a long time about which was the most convenient treatise for the education of young people [...] I therefore applied myself to a course of lessons which, neither too elementary nor too sublime, allow to easily read the [...] astronomical works published in the Ephemerides (Santini 1830, p.III).

As a general purpose he states:

It has seemed to me expedient to stick to the plan of going back from combined astronomical observations and discussed with each other to the cognitions of the laws, which the celestial bodies obey with such regularity (Santini 1830, p.V).

Domenico Turazza (1813-1892) graduated in mathematics in Padua, taught Descriptive Geometry in Pavia and then Geodesy and Hydrometry in Padua, director for life of the School of Application for Engineers and finally Senator of the Kingdom. He was a member of more than thirty academies and scientific societies. He published 90 works mainly scientific but also literary.

Turazza wrote eight texts dedicated to teaching, two of them for high school education. We consider here the text *Trattato di idrometria ad uso degli ingegneri (Treatise on Hydrometry for the Use of Engineers)*. In the preface he states:

The desire to place in the hands of my young students a book, which, beside serving them as a guide in the ordinary course of my lessons, would also return to them as a benefit in the practical exercise of this difficult part of their profession, was an incitement to me (Turazza 1835, p.3).

But what was his idea of hydraulics?

Anyone who has set his mind to the study of hydraulics, will have of light noticed that that part of it, which more properly belongs to practice, receives almost no support from general theories, (Turazza 1835, p.3).

He goes on to explain that all the theoretical researches made, in which he took part, are but mere hypotheses, from which practice can derive no benefits. The dozens of authors covered in this text, both Italian and foreign, make this text a comprehensive compendium for knowledge on the subject at the time. Turazza was one of the leading European hydraulic engineers of the

nineteenth century. Antonio Favaro, one of the prosecutors of the Paduan school of which we speak here, stated on his Master:

In all the scientific works to which I have alluded and in the others I will still touch, he [Turazza] appears mainly and above all a Master: teaching is always his supreme aim, and if at times he seems to deviate and depart from it, he returns to it very soon and for the deviation he shows discontent and repentance (Favaro 1892, p.7).

The third and final figure we discuss is Giusto Bellavitis (1803-1880). Regarding this mathematician we have at our disposal a great deal of manuscript material in addition to his numerous publications. Although he did not follow a regular course of study, in fact he was self-taught, he dedicated much of his life teaching and studying how to teach best. He was inspector of the Scuola Reale Superiore in Venice, a member of the Society of XL and of Accademia dei Lincei. From 1866 he was a senator of the Kingdom of Italy. He published 223 papers, many devoted to education in general and many to the specific teaching of various subjects; he published the *Rivista di Giornali* containing many articles on school and university. Among the publications, the *Lectures on Descriptive Geometry with Notes* of 1851 represent an important example of the application of Bellavitis' theories on teaching. The preface proposes:

Of every problem I first gave the general solution in words only and without the aid of figures; with this I tried to exercise the mind and imagination of the scholar, and also wanted to avoid that kind of teaching for particular cases (Bellavitis 1851, p. VII).

For the author, writing has drawing as its big sister, the purpose of Descriptive Geometry is to give rules and principles to drawing, solving problems of the geometry of space or even representing a three-dimensional object in a plane. This is the first didactic work in Italian to deal with topics that for the time were recent, set forth in German and French texts; thus the author had to create neologisms. Topics range from definitions of geometric entities to intersections of surfaces, from contacts (tangential, etc.) to curvatures of lines and surfaces. Of these lectures we also have the handwritten version, which the mathematician used in his lessons.

Bellavitis describes the design, the way to make it, and only later proposes its algebraic-analytic solution. We recall that the manuscripts binder also contains documentation on exam questions, student papers, evaluations and considerations of the results obtained by the teacher.

2 A 100-year-long article

Bellavitis in the 1853 work *Riflessioni sull'istruzione pubblica* (*Thoughts on Public Education*) (Bellavitis 1853) clearly shows us his position towards learning in general, the problems of the time and the solutions he would implement. He deals with education from the earliest age to university studies. Before we analyze some essential points, still strongly relevant today, we report here an emblematic sentence by Bellavitis in a letter dated June 22, 1860, (Mazziniano Museum in Genoa, Cremona-Cozzolini Fund) to the young Luigi Cremona who would shortly start the teaching of geometry, “you will need to remember that profit is measured not by the much taught but by the little that is well learned”.

With the principle that the path of all teaching should go from what is already known to what has to be learned, the author proposes a division of studies by age: 6-10 years old, compulsory general studies where one learns to read, write, count; the main subjects are: arithmetic and Italian language; from age 10 to 15, general higher studies (principles of letters and science to which no one of civilized condition can be ignorant); from age 15 to 18, studies for start-up to university (with freedom of final choice in university career) or studies for ecclesiastical status or for the various professions. A futuristic vision, since in the mid-nineteenth century a high percentage of the population of Lombardo-Veneto and the rest of Italy was illiterate. Regarding textbooks, especially for the first cycle of studies, Bellavitis sets out his concerns:

It cannot be hoped that in elementary education teachers will know the best way to teach, nor can this be learned with some pedagogical lessons; therefore it will not infrequently happen that a teacher, taking the narrowness of his ideas as the norm, judges pedantry the convenient development of the subjects of a text established for the instruction of young minds (Bellavitis 1853, p.127).

In the 1853 work, there are also considerations of examinations to be held each year with the own teacher and at the end of each course examinations also with teachers of the next course; it is important establishing a merit ranking and exams for admission to new courses; to introduce possible honorary rewards as a mean to achieve results. In that period, for the teaching of geometry, there was a great debate concerning the effectiveness of the Euclidean method. The discussions led to numerous articles and school texts that went in this direction. Bellavitis exposed his thinking in these terms:

On the subject of the theoretical teaching of geometry I do not share the opinion, on the other hand very respectable, that the method of Euclid must be followed, and that it is useful to exercise the scholar in a series of linked arguments; I would prefer to make the road as flat and easy as ever possible (Ibid., p.155).

This work is a clear representation of the school situation of the time and Bellavitis' plans for education. It would take Italy more than a century to implement certain ideas. The mathematician was also asked by the University of Padua to draw up a plan for restructuring the teachings of the Athenaeum. He set it out in a lengthy manuscript also found in the papers of the Veneto Institute's archives, where all the files that go into the merits of the contents of all the teachings are also kept.

Conclusions

We can speak of a Paduan school because we identify a group of mathematicians who were university professors in Padua, friends, members of institutes and academies in Veneto, in continuous correspondence. The studies and proposals for education, of the discussed authors, showed up in part in the laws of united Italy (the exchange of letters with L. Cremona, F. Brioschi, E. Betti and others is interesting in this area). The dimensions of the dynamics related to the teaching of mathematics and in particular geometry, at that time in Padua, are on a European level. Regarding this, we recall that much of the mathematics taught today in high schools and universities took on its current appearance during that historical period. Bellavitis asks himself which is the best way to recruit teachers, what characteristics they should have and how to identify them. It is interesting to note how there is a cyclicity that becomes fashionable, in the various historical periods, concerning the curvature that the teachings should take; for example, Euclidean geometry has popped up three times in the last two centuries, as well as the importance of the ancient languages Greek and Latin as the basis for everything else in knowledge. In a less obvious way this occurs in all subjects. This depends on the alternating sensitivity of human groups compared to the perception of the concrete world and its mental representations.

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