

Physics literacy of society- the unknown interest of Marian Smoluchowski

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Marian Smoluchowski, the outstanding physicist was also a great personality from an intellectual and ethical point of view. He considered it as a duty of high priority to contribute to raising the scientific literacy of his homeland. His contribution in the form of a book “Manual for Self-study, Physics” contains very deep thoughts about physics teaching and physics studying. Smoluchowski with his interests in physics education and philosophy of science, was not an exception among his contemporary physicists. The coming explosion of physics was prepared by recognition of importance not only of good physics teaching but also by increasing the science literacy of societies. The very exceptional in Smoluchowski’s activity was its practical dimension. Because of language barrier was not widely known. The aim of this paper is to remind it.

The public and democratic education, in western sense, got its contemporary meaning over hundred years ago. Physicists also contributed to that. Outstanding physicists devoted their attention and time to philosophical and educational problems. The ideas of scholars like Poincare, Mach, Ostwald and Einstein were disseminated widely and enjoyed a tangible influence on the development of philosophy of science and also influenced a way of teaching physics, and education in general. The methods of teaching physics were codified in 1905 in Merano by Education Committee of the Congress of the Society of German Natural Scientists and Doctors (see Appendix). These modern recommendations had been presented to Polish physics teachers and physicists by Smoluchowski. Smoluchowski did much more than only popularisation of western ideas. He devoted part of his last period of life to the preparation the book “Manual for Self-Study, Physics” [1], which in reality is not only a collection of deep thoughts about physics education, but also very useful, practical guide for teaching and self-studying of physics on any level. The book, with such an innocent tittle and of a moderate size gives “complete” insight in physics education (nothing has to be added or removed, like in Mozart symphonies). To visualise the quantitative changes in physics itself and in physics education one should compare the size of the small 270 pages of A5 book, containing the list of physicists from all over the world, also manufactures of physics instruments, universities [2] (“Adressbuch der Lebenden Physiker, Mathematiker und Astronomen des In- und Auslandes”, Leipzig 1909) with the lists of members of European Physical Society, or American Physical Society. Seeing such changes we can rightly ask what remains from the ideas of Smoluchowski about physics education. We have to ask what became obvious and is commonly accepted, what became obvious, but in praxis is accepted, what became rather old-fashioned, and what is rejected and even replaced by reverse ideas.

Over a hundred years ago, when partitioned Poland was in economic, cultural and scientific backwater, the country’s more enlightened and farseeing individuals understood that the one sure way out of this state of stagnation led through the raising of her standards of education and culture. The original project, namely publication of so called *Manual for Self-Study* was launched. The most outstanding Polish scholars of the time, many of them enjoying a European reputation, (just to mention a few names as the logician J. Lukasiewicz, the mathematicians W. Sierpinski, S. Zaremba, S. Mazurkiwicz, Z. Janiszewski, the sociologist L. Krzywicki) participated in the project. Successive volumes in the publication were marked by a very high academic standard, and they recorded the latest scientific achievements. The first volume edited in 1898 was devoted to the mathematical and natural sciences [3]. The description of the project is presented in the publication “Marian Smoluchowski and Physics Education”[4] by the author of this article.

The aim of this paper is to draw attention to the educational activity of Marian Smoluchowski. He gave this activity first priority, even before purely scientific research. In the brief last period of his life spent in Cracow Smoluchowski dedicated a lot of work to this *Manual*. In the letter to his wife Zofia, from August 5th, 1916 he wrote: *I have the feeling that this work contains a part of myself* [5]. He put a huge amount of effort and his didactical zeal into the task, along with his personal experience from the time of his work at the University of Lvov. Perhaps Smoluchowski's great qualities as an educationalist were to some extent influenced by Hoefler, his illustrious teacher. Smoluchowski had attended the famous *Collegium Theresianum* in Vienna, one of the most outstanding schools in Central Europe, where Hoefler was the physics teacher.

The *Manual* [1] dealing with physics was compiled by Smoluchowski. In essence, it is a guidebook for teaching of physics. The range of material included is most impressive in that in all the sections it gives the impression of a firsthand compilation. Although Smoluchowski himself was not a school teacher, his deep study of his contemporary teachers and his pedagogical instinct permitted him to write a real masterpiece. The reader can find here an essay on the methodology of teaching at the lowest level and a chapter on the choice of subject for academic study as well. A list of firms supplying apparatus and e.g. the address of the secretary of the Institut de France is also included for convenience of the readers. More than 500 bibliographical items, in English, French, German and Polish, scrupulously and objectively reviewed with regard to the potential reader, complete each part. There is a splendid, fascinating introduction to the *Manual*, in which Smoluchowski gives his own brief picture of the structure of physics and of its research methods. This pithy essay, still full of interest for us today, carries the stamp of philosophical erudition and discipline and originality of thought.

Instead of summarising Smoluchowski's idea it is rather worthwhile to quote him. Below are some quotes related to the teaching of physics in Stage I (age of 10-14), i.e. in elementary instruction. The reason of choosing this one is the following: in western countries elementary teaching became absolutely obligatory. Science is included in every school curriculum. This introductory teaching is under strong influence of the results of modern psychology. It is the subject of didactical experiments, which are in the focus of interest of many societies.

The capacity to understand physics and to assimilate its scientific methods depends above all on the level of one's training in precise mathematical thinking. For a person not possessing any training of this kind, only the rough qualitative aspect of physical phenomena may be grasped; familiarity with the four basic arithmetic operations and with elementary geometry enables student further to understand certain of the most simple quantitative laws, Smoluchowski asserts.

Learning at the first stage ought to be guided by a *naive view of the world*, Smoluchowski stated. Nowadays a lot of research is done on the ideas of children in science; the results of this research are helpful in designing a physics education for very young students.

To familiarize the learner with the basic laws of Nature and to facilitate an understanding of the phenomena of the world of physics is the main goal of elementary education, Smoluchowski stressed. He wrote that *these aims may be achieved only through the most active possible participation of the learner and through his having direct contact with facts of nature*.

Today nobody is questioning this, it is so obvious, but it does not mean that in praxis this recommendation is followed.

It seems that today too much hope is put on children's inquiry and that another remark of Smoluchowski's is forgotten:

Of course it is out of the question that in a few years of study at school the child should discover independently what generations of scholars have spent their whole lives studying. For this reason, one should rather ... guide them gradually along their own path. This path is an arduous one, for one cannot demand too much of the creative imagination of a child, and I would consider it as a great exaggeration to suggest that the whole course of physics should be directed in this way.

A child's own inquiry, which is very necessary in their physics education, is treated as a *panaceum* for all problems in education. However, it remains mainly on paper, because for real inquiry methods one needs a very highly educated physics teacher and also a lot of time for teaching in small groups, not in crowded classes. It is a very expensive method of teaching. Very seldom all conditions are fulfilled.

Let us read another quotation of Smoluchowski:

In general, it is necessary to resist the erroneous belief that ... the experimental part should be only regarded as a game. As for exercises and cultivation of dexterity are concerned, it should be left to the pupils to discover in a game; learning however, should be based on experiments carried out methodologically and purposefully.

This statement of Smoluchowski is against the present trend in physics education on elementary level. We are suffering of a crisis in interest in physics learning; physics is one of the most hated subjects in school. It is the reason that physics educators are doing nearly everything to make physics fun, attractive and easy for everybody. Games, toys, even drama are present on physics lessons [5].

In the section on supplementary monographs Smoluchowski quoted C. R. Mann's: *The teaching of Physics for Purposes of General Education* (1912):

The aim of the author is to bring physics closer to the pupil's everyday life ... in the main, Mann's exposition is successful; we are struck only by one unpleasant and purely American feature: an over-explicit emphasis on technical – utilitarian matters thought to be the only way of interesting the pupils.

At the beginning of the XXI century the opinion of Mann is prevailing [6]. In Europe this, as Smoluchowski called it, utilitarian way of teaching was reaching recognition very slowly and painfully, to be accepted nowadays without even a sign of critique. It looks as if the world needs highly specialised workers, rather than deep thinkers. The future will show that this approach to teaching is optimal for the generations of the XXI century.

When one compares the beginning of the XX century with that of the XXI one sees an absence of great personalities both in physics and in science education. It also seems that physicists of the last decades of the XX century neglected physics education. With arrogance they believed in a permanent admiration of physics by societies. It was the XXI century conference at CERN “Physics on Stage” in which physicists of the leading world institution seriously noticed the problem of scientific literacy in XXI. To stimulate readers of this article to reflection on changes in education and about future physics teaching, an appendix is given, containing the 1905 Merano recommendations, and the 2000 Geneva “Physics on Stage” recommendation.

References

- [1] Poradnik dla Samouków, Vol.II, Fizyka i Geofizyka (Manual for Self-Study, Vol.II, Physics and Geophysics, Meteorology), Warszawa 1917, Michalski i S-ka
- [2] Adressbuch der Lebenden Physiker, Mathematiker und Astronomen des In- und Auslandes”, Leipzig 1909, Verlag von Johann Ambrosius Barth
- [3] Poradnik dla Samouków, Matematyka i Filozofia Naturalna (Manual for Self-Study, Mathematics and Natural Sciences), Michalski i S-ka, Warszawa 1898
- [4] Marian Smoluchowski and Physics Education, “Manual for Self-Study”, Zofia Golab-Meyer, Essays devoted to Scientific and Didactical Work of Marian Smoluchowski, Edited by Bronisław Sredniawa, Universitatis Jagellonicae, Folia Physica, MXXXIII, Krakow 1991
- [5] Marian Smoluchowski – Leben und Werk, Armin Teske, Monografie z Dziejów Nauki i Techniki, PAN, Ossolineum 1977
- [6] Physics on Stage, Full Proceedings 2000, Geneva, European Space Agency, SP-497, July 2001

Appendix

Merano (1905) recommendation of Educational Committee of the Congress of the Society of German Natural Scientists and Doctors:

- 1/ Physics should be taught as a natural science, not as mathematical science.
- 2/ The teaching of physics ought to offer an example as to how, in general, knowledge is acquired in the field of natural science.
- 3/ It is essential that learners should be given systematic exercises in independent observation and experimentation.

Physics on Stage, Geneva 2000.

Consideration of the major Issue of Today. Recommendations:

- It should be recognised that physics has immediate relevance in understanding and solving problems of sustainable and development growth.
- A curriculum should address the above issues and immediate impact of physics on everyday life, based on complex, interdisciplinary approach.
- [...]
- Students and teachers should be given reliable information from variety of sources, which is up-to-date and free from propaganda.
- Curricula should enable students to take reasoned decisions, weighting up evidence and risk in a social and economic context.

Compare it with Smoluchowski (from the talk at the Congress of Polish Teachers, Cracow, 1917):

...the sciences have from time immemorial been antidote to the poison of blind faith in authority and of the slavish subservience of minds; they struggle with humbug and platitude-sicknesses that foster in our society and disfigure our mother tongue.

