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INTERNATIONAL CONFERENCE ON NEW HORIZONS IN EDUCATION



INTERNATIONAL DISTANCE EDUCATION CONFERENCE



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Dear Guests...

Welcome to the 8h INTE & ITICAM & IDEC -2017.

International Conference on New Horizons (INTE) and, International Trends and Issues in Communication & Media Conference (ITICAM) and International Distance Education Conference (IDEC) are international academic conferences for academics, teachers and educators. They promote the development and dissemination of theoretical knowledge, conceptual research, and professional knowledge through conferences activities, the conference proceedings books and TOJET, TOJNED Journals. Their focus is to create and disseminate knowledge about new developments in these academic fields.

INTE & ITICAM & IDEC conferences are now well-known international academic events and the number of paper submissions and attendees are increasing every year. This year our conferences have received more than 900 applications. The Conference Academic Advisory Board has accepted approximately 600 papers to be presented in Berlin, Germany.

We would like to thank Prof. Dr. Muzaffer ELMAS, Rector of Sakarya University for his support of organizing these conferences.

We also would like to thank our distinguished guests, keynote speakers for their collaborations and contributions for the success of these conferences.

And finally, we would like to thank to all of our participants who have presented their academic works in INTE & ITICAM& IDEC- 2017, Berlin, Germany.

Without their participation, INTE, ITICAM & IDEC-2017 would, of course, have been impossible.

We would like to sincerely thank all of you for coming, presenting, and joining in the academic activities.

We would also like to thank all of those who have contributed to the reviewing process of INTE, ITICAM & IDEC conference papers, which will be also published in TOJET, TOJNED.

Finally, we would like to wish you all a successful conference, pleasant stay in Berlin, Germany.

Thank you

Coordinators

Prof. Dr. Aytekin ISMAN

Assoc. Prof. Dr. Ahmet ESKICUMALI

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HOW TO TEACH MATHEMATICS: SOME SUGGESTIONS FROM HERBARTIAN TRADITION

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ABSTRACT

The German Johann Friedrich Herbart (1776-1841), recognized in mathematical psychology as a forerunner in the measurement of mental phenomena – in a study of psychic events which was not only qualitative but also quantitative, based upon mathematics (specifically, calculus) –, stood out also for his activity in the psycho-pedagogical field and for his theory of education, in which mathematics played a fundamental role. His contribution was, in particular, considerable for mathematics education between 1800 and 1900 in the world of German culture, where important reformist tendencies in the study of teaching problems matured. After a brief sketch of Herbart's life and work, the paper will focus on these aspects, giving methodological suggestions which can be relevant and useful for mathematics education of today.

1. JOHANN FRIEDRICH HERBART (1776-1841), A BRIEF SKETCH OF HIS LIFE AND WORK

Born in Oldenburg, capital of the Grand Duchy of the same name (now in Lower Saxony), Herbart studied philosophy at the University of Jena, where he was a pupil of Fichte (see Raapke, 1976). Employed as a private tutor in Bern, Switzerland, Herbart visited the Burgdorf Institute founded by Johann Heinrich Pestalozzi (1746-1827) and established a friendship with him. Having been “Privatdozent” first of pedagogy and then of philosophy at the University of Göttingen, in 1809 he accepted the call to take up Kant's chair in Königsberg (now Kaliningrad; at that time Eastern Prussia). There, Herbart found a favourable environment for his work and collaborated, with government support, in commissions and school reform projects. In 1833, he went back to Göttingen, where the chair of philosophy was vacant.

1.1 HERBART'S THEORY OF EDUCATION

Besides his philosophy, which he developed in opposition to idealism (at that time dominating the German world of culture) as an elaboration of concepts obtained by experience, Herbart stood out also for his activity in the psycho-pedagogical field and for his theory of education.

In this context, he conceived “pedagogy” as an organic system of concepts concerning the aims and the methods of education (see Benner, 1976; Blaß, 1976; Geißler, 1976; Raapke, 1976). In order to be a science, pedagogy needs a basic philosophical doctrine, specifically “psychology”, able to provide necessary knowledge about nature and development laws of the human soul, and also “ethics”, capable of showing the ideal aims of life to which the process of training the student's personality should be directed.

Education can be accomplished, according to Herbart, only through “instruction”, and “educational instruction”, to be such, must be able to arouse what he calls “interest”. Interest is conceived in this regard not only as an educational tool to ensure that what is taught is more readily understood and learned by the student, but also and above all as an end to which education should be directed. It must be considered as an aptitude to grasp the value of the aspects of life and reality and, consequently, to assume a corresponding practical attitude. Educational instruction must make interest grow in all directions, in a simultaneous, coordinated, and harmonious way. The student must be educated in his entirety, at all times, so as to realize the organic unity and development continuity of his inner life, with the purpose of “multilateral culture”.

2. HERBART AND MATHEMATICS

“Mathematics, a foreground discipline”: So Herbart's position on mathematics can be outlined.

Herbart is well known in mathematical psychology as a forerunner in the measurement of mental phenomena, in a study of psychic events which was not only qualitative but also quantitative, based upon mathematics (specifically, calculus) (see, for more details, Leary, 1980; Romano, 1976; Zudini, 2009a, 2009b). In fact, inspired by Kant's dictum that science was necessarily mathematical and in answer to his famous interdiction – which affirmed the impossibility of a mathematization of psychical facts, since they took place along one dimension, time, and were devoid of spatial extension, being intensive magnitudes – Herbart affirmed not only the possibility but the necessity of applying mathematics to psychology (Herbart, 1822), conceived as “science, newly founded on experience, metaphysics and mathematics” (Herbart, 1824-1825).

According to Herbart, if psychical magnitudes, considered singly, cannot be measured, nevertheless, we can measure the variation of these magnitudes in a direct way, through calculus (the “mathesis intensorum” of that period). In case of shortage and imprecision of empirical observations, we can follow an indirect way, using the predictive power of the mathematical formulation.

The magnitudes which Herbart put at the basis of his calculation were the force of representations and the grade of contrast between them: The representations, which constitute our mental life, clash and, as a consequence of these interactions with stronger or weaker representations, fuse with or inhibit one another, reach or leave consciousness when they exceed or go below the threshold value (“Schwelle”). Once this value has been reached, representations remain in a sort of state of latency, waiting to return to consciousness. All that takes place in the context of a sort of mental “statics” and “mechanics” (Heidelberger, 1993). So “consciousness threshold” (or “limen”) is a fundamental point of Herbart’s theory: He introduced this concept in psychology and defined it, with calculation methods (concerning the history of the concept and its application in psychology, see Corso, 1963).

In Herbart’s vision, mathematics is therefore fundamental but not only in this respect. It has a basic role also in education, as “gymnastics” of thought, for the formation of the mind, in all its degrees (Herbart, 1804).

In fact, the mind, as well as the body, needs to find a “gym”, to test the “muscles” and renew the “elasticity”. In this context, the importance of mathematics is affirmed for all scientific disciplines; the teaching of mathematics should not be reserved for the last years of formation, but imparted from the earliest years in order to avoid a late, superficial, and hence fruitless learning of it.

Thus, mathematics plays an irreplaceable role in a complete education of young people.

3. FROM MATHEMATICS TO MATHEMATICS EDUCATION

Since mathematics was a foreground discipline, mathematics teaching became a major matter of study for students’ education as a whole.

The trace of Herbart’s influence is clear and recognized in the German cultural world between 1800 and 1900, and, specifically, his contribution was significant for mathematics education of that time, where important reformist tendencies in the study of teaching problems matured. It was a very fruitful period of research and deepening the understanding of these problems, in particular in the Middle-European cultural world, both for the innovation of the teaching methods and for the introduction of new subjects in the secondary school, first of all calculus (see Zuccheri & Zudini, 2014). In Göttingen, where Herbart had been professor, a prominent scholar of didactical problems was the mathematician Felix Klein (1849-1925) (see Corry, 2004).

An opportunity to examine and discuss the situation of mathematics education in various countries, with reference also to psycho-pedagogical considerations, was the Fourth International Congress of Mathematicians held in Rome (April 6-11, 1908). On that occasion, the “Commission Internationale de l’Enseignement Mathématique” (CIEM) or “Internationale Mathematische Unterrichtskommission” (IMUK) – thereafter, “International Commission on Mathematical Instruction” (ICMI) – was established, presided over by Klein, with the aim of promoting and spreading the interest of the mathematicians in school education. Together with this commission, the journal “L’Enseignement Mathématique” played an important role allowing communication and cooperation among scholars at international level (see Schubring, 2003, 2008; Furinghetti, 2003; Furinghetti et al., 2008).

Focusing on these aspects is of interest in so far as suggestions, which were drawn at that time, were destined to have rich developments, still resounding in current research in education and being relevant and useful for mathematics education of today.

3.1 METHODOLOGICAL SUGGESTIONS FOR MATHEMATICS TEACHING

Herbart had a significant influence on elementary school education. Traces of this influence were evident in most geometry textbooks for elementary schools of Klein’s time. In preschools (“Kindergarten”), according to Pestalozzi’s theory of intuition (“Anschauung”), picked up by Herbart, young children learned about the simplest spatial forms by playing with suitable objects.

These pedagogical ideas had been applied also in higher level schools. The school curricula proposed by Franz Serafin Exner (1802-1853) and by Hermann Bonitz (1814-1888) in Austria already around the middle of the nineteenth century adopted the “new” intuitive methods.

The same trends came to the fore, at the beginning of the seventies of the nineteenth century, in Prussia and, in general, in northern Germany. Instead of a rigid theoretical complex, like that of Euclid’s, a natural theoretical path, stimulating the students’ experience, should be preferred. In the specific case of geometry, the starting point was represented by drawing and construction, giving particular value to the formation of space intuition (see, in general, concerning geometry teaching and its history, Barbin & Menghini, 2014).

In Germany, as well as in the other countries, around 1890, new orientations were present, beside these ideas.

Firstly, a strong movement had set up, which wished for a deeper understanding of the applications of mathematics in all branches of natural sciences, particularly in technology, and of its importance for all aspects of human life. With this movement reformative trends were connected, which saw in the teaching of the concept of function, of graphic methods and fundamentals of calculus new stimuli for geometric teaching (see Zuccheri & Zudini, 2007, 2008). Klein himself, on the one hand, stressed the need to adjust the teaching methods and content to contemporary cultural trends and to demonstrate the way mathematics was applied in natural sciences and technology. On the other hand, he was convinced that there should not be too-clear distinctions, in teaching, between the various sections of mathematics, actually citing arithmetic and geometry as examples. He also highlighted the possibility of introducing students fairly early to the concept of function, using analytical geometry (see Klein, 1925, pp. 226ff.).

The mathematicians of Klein's time had, more than in the past, to deal with theories that were the result of "modern" psychological research, particularly in the field of experimental psychology. Beside Herbart's research, for example, the study of memory and of fatigue, conducted at that time by Hermann Ebbinghaus (1850-1909) (see Ebbinghaus, 1895) and by Georg Elias Müller (1850-1934), the director of the laboratory in Göttingen and successor, after Rudolph Hermann Lotze, to the chair of philosophy that Herbart had occupied (see Müller, 1911-1917), should be mentioned.

An important subject, precisely concerning mathematics, was that of individual differences in "talent" and intelligence. After a first period in which people had believed that "mathematical talent" existed – meaning with that expression that only students gifted in mathematics were able to understand mathematics – following the educational plans of Exner and Bonitz, a greater value was given to pedagogy and the opposite opinion developed, affirming that every student with good will and some effort (even by the teacher) should be able to learn mathematics.

In this context, also studies of the different mathematical "species" of mathematical talent were included, that is, for example, the commonly observed fact that a mathematician is more gifted from an arithmetic, abstract point of view than the one more oriented to work with intuitive shapes, from a geometric point of view. Studies had already been done on people who had developed remarkable capabilities in a well-defined field, such as those with significant computational capacity or chess players (see Binet, 1894).

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