Oral Presentation

THE BELGIAN JOURNAL *MATHEMATICA & PAEDAGOGIA* (1953-1974): A FORUM FOR THE NATIONAL AND INTERNATIONAL SCENE IN MATHEMATICS EDUCATION

Dirk De Bock & Geert Vanpaemel

KU Leuven, Leuven, Belgium

In 1953 the Belgian Society of Mathematics Teachers was founded. The Society brought together a few hundred mathematics teachers from both linguistic communities (French and Dutch). It started its own professional journal Mathematica & Paedagogia (M&P). Willy Servais, the Society's first president, became the journal's figurehead. Servais was an open-minded, inspiring personality and an unconditional proponent of international exchange in mathematics education. In the 1950s M&P became an international forum of ideas, in particular for members of CIEAEM. In this paper we present some of the main themes discussed in M&P, with particular focus on the contributions by international scholars. Although the influence of the French structuralist mathematicians was clearly discernible, the pages of M&P were also open to other scholars.

INTRODUCTION

When in 1953, the *Belgian Society of Mathematics Teachers* was founded, it immediately started its own professional journal *Mathematica & Paedagogia* (*M&P*) (Miewis, 2003). From the beginning, the journal was bilingual, with articles in French and in Dutch, serving both linguistic communities in Belgium, although in its early years, most contributions were written in French. The foundation of the *Belgian Society of Mathematics Teachers* is closely related to the activities of CIEAEM, the *International Commission for the Study and Improvement of Mathematics Teaching*. *M&P* ceased publication in 1974 when the Belgian Society was restructured on a linguistic basis into a Flemish and a French-speaking Society of mathematics teachers.

During the fifties and sixties, the main personality of the *Belgian Society of Mathematics Teachers* and its journal *M&P* was Willy Servais (1913-1979) (Vanpaemel, De Bock, & Verschaffel, 2012). Servais was one of the founding members of CIEAEM (Bernet & Jaquet, 1998) and he was quickly convinced of the need to ensure a structural relation between the work of the CIEAEM and the community of Belgian mathematics teachers. To that purpose, Servais took the initiative to found the *Belgian Society of Mathematics Teachers.* He became its first President, a position which he held until 1969. He also served on the editorial board of *M&P* and became the journal's figurehead. Servais was an open-minded, inspiring personality and an unconditional proponent of international exchange in mathematics education. Already in his first *Editorial* for *M&P*, Servais held a strong plea for international cooperation. He wrote: "Mathematics as a truly universal language, has,

by its nature, an international vocation; we will open our columns to our colleagues of other countries" (Servais, 1953, p. 4). Besides, the establishment of relations with foreign associations of mathematics teachers, as well as with other international organizations sharing similar goals, were formally included as important objectives of the new Society.

Servais' plea was received favourably by the international math and mathematics education community of that time. Several famous authors submitted contributions. The Belgian journal rapidly became a forum for national and international exchange in mathematics education. Before discussing some key contributions by international scholars and entering the debates of that time, we first explain how the content of *M&P* was structured.

STRUCTURE OF *MATHEMATICA & PAEDAGOGIA*

The first 26 issues of *M&P*, covering the period from 1953 to 1964, had a recurrent structure with clearly distinguishable sections. The journal opened with an *Editorial*, in most cases written by Willy Servais himself. In these Editorials, Servais reflected on pedagogical and other issues, such as the initiatives of the Society or political decisions that had an impact on the teaching of school mathematics.

The first section was devoted to *"Culture mathématique"* (*Mathematical culture*). Main goal of that section was to inform the readership about new developments in mathematics. Most of the articles in that section were written by French and Belgian university professors in (pure) mathematics, including renowned scholars like Jean Dieudonné, Henri Cartan, Gustave Choquet, Paul Libois and Georges Papy. Needless to say that the axiomatic and structural approach, dominant in the French mathematical culture of that time, was reflected in most of these contributions. Because mathematics education is our main point of interest, we will not discuss in depth the purely mathematical articles that appeared in that section.

More interesting in the context of this paper is the second section entitled *Knowledge of the pupils*. In a letter, included in the first issue of *M&P*, Caleb Gattegno stated that *M&P* was the first mathematical journal in the world that reserved some pages to pedagogical research (Gattegno, 1953). Indeed, for Gattegno, Servais, and other CIEAEM members of that time, it was clear that successful teaching of mathematics not only depended on the teacher's expertise in mathematics, but also on his or her knowledge about pupils' development and thinking. In this section of the journal, one can find reports of experimental lessons focusing on pupils' behavior, their correct and incorrect ways of thinking, interpretations of their reasoning, contributions on, what we would call nowadays the "psychology of mathematics education". However, in contrast with contemporary approaches, these contributions, mostly written by mathematics teachers, did not follow a strict experimental methodology. Pupils were observed in the context of real lessons and their individual or collective reactions were described and interpreted.

The third section of *M&P* was called *Instruction* and provided resources for teaching school mathematics (topics for the mathematics classroom, successful didactical approaches, and helpful models and devices). It was the journal's central section, typically covering the majority of its articles. In most *M&P* issues, a fourth section was devoted to *Applications of mathematics* in other sciences. In the context of this paper, however, the subsequent section *Contacts* deserves more attention. It presented the Society's international network of math educators, including Gustave Choquet, Lucienne Félix and André Fouché in France, Caleb Gattegno and Trevor Fletcher in the UK, Félix Fiala and Jean Louis Nicolet in Switzerland, Emma Castelnuovo in Italy, and Friedrich Drenckhahn in Germany. Most of them were early CIEAEM members, Servais' main international network. In *M&P* 5, new contacts with the Dutch associations of mathematics teachers and with the *National Council of Teachers of Mathematics* (US) were announced and their respective journals were introduced to the Belgian community of mathematics teachers. In the *Contacts* section, one can also find reports of eight early CIEAEM meetings (CIEAEM 6, 7, 8, 9, 10, 11, 17 and 18). Because there exist no published Proceedings of these meetings, these reports are one of the rare sources that can give us some insight in how CIEAEM functioned at that time and in the topics being discussed at these meetings.

In the section *Books and journals* mainly international publications in the field were reviewed. In the section *Questions and problems*, problems of official (entrance) exams in Belgium, but occasionally also from other countries, were proposed. Finally, there was an *Administration* section that informed the readership about the Society and its initiatives.

INTERNATIONAL SPOTLIGHTS ON NEW TEACHING AIDS

Several articles by internationally renowned scholars in the field of mathematics education were published in *M&P*. Probably, they were invited to submit a paper by Servais who knew most of them personally from CIEAEM meetings. Until the late 1960s, *M&P* and similar professional journals in other countries, were one of the rare channels to publish work in this field. *L'Enseignement Mathématique*, for a long time the only international journal on mathematical instruction, had become at that time a purely mathematical journal (see Furinghetti, 2009) and *Educational Studies in Mathematics* was only founded in 1968.

A key contributor in the 1950s was Caleb Gattegno (1911-1988), at that time working at the University of London. In *M&P* 3, Gattegno explained his pedagogical approach towards mathematics education in an article on intuition, elaborating on his well-known "pedagogy of situations" (Gattegno, 1954a). According to Gattegno, pedagogical principles should be based on the observation of human learning in many and varied situations. How a student adequately restructures a situation is not a simple response to a stimulus, but a complex interplay of different factors, including affective ones. To find guiding pedagogical principles for the improvement of education, classes should be reshaped into real educational laboratories.

An important topic for math educators in the 1950's was the use of teaching aids. From the very beginning Gattegno showed himself a virulent advocate of the Cuisenaire rods, a set of colored sticks of different lengths that can be used as a didactical tool to discover and to explain various mathematical concepts and their properties. This teaching aid was invented by the Belgian primary school teacher Georges Cuisenaire (1891-1975) and Gattegno became their worldwide ambassador (Gattegno, 1988). In an article that appeared in *M&P* 4, entitled "Colored numbers", Gattegno described the Cuisenaire rods in a lyrical, fairy-tale style:

> Once, there was a primary school teacher (…), who loved his pupils so much that he asked himself what he should do to make the compulsory study of arithmetic look easy to them and give them joy. Where would he find the answer to his question? To consult mathematicians is useless. They do not understand the difficulties children are faced with. Similarly, it does not seem that the aid of psychologists will help us more because their knowledge about what a child can do is much separated from the educational system which determines the child (…). The land, in truth, was a virgin and was missing a brand new idea that would shed new light on the problem. Georges Cuisenaire, primary school teacher in Thuin, did find that idea in the art of music he was always practicing. (Gattegno, 1954b, p. 17)

Gattegno considered the invention by Cuisenaire as the most important contribution in the efforts to find solutions for the problems faced in arithmetic education and he illustrated the rods' various applications. Then, he showed how the rods can also be used in other domains, such as algebra, measurement and geometry. Gattegno considered the rods as a symbiosis between mathematics, educational technology and educational science. From a mathematical point of view, they put the spotlight on relationships and structures. From a psychological point of view, they stimulate intuition and facilitate discoveries. Many other articles in *M&P* came back to the use of Cuisenaire's "colored numbers". These articles often reported about experimental lessons as presented and discussed at national and international conferences during the 1950s.

Teaching aids and models, such as the Cuisenaire rods, were a central topic in the 1950's debates. These didactical tools were basically seen as bridges between intuition and abstraction. In the opening session of CIEAEM 11, summarized in *M&P* 12, the Spanish mathematician Pedro Puig Adam (1900-1960) described their role in mathematics education as follows:

> These tools (…) will not be considered as a set of simple concrete illustrations, as appropriate clothing, to facilitate momentarily an uneasy understanding. For the educator who does not forget the perspective and initial processes of abstraction, these tools are much more, they represent something substantial in their educational function. These tools, structured in the form of models, do not only have the objective to occasionally translate mathematical ideas, but also to suggest them and being at their origin. (…) The old model of a showcase, to be passively completed by the pupils, should make room for multivalent newly designed tools, tools that can be manipulated by the pupils and that in

> the meantime induce an activity that creates the knowledge they have to acquire. (Puig Adam, 1957, p. 64)

Another tool, invented by Gattegno for geometry education and discussed from various perspectives, was the geoboard (Vanhamme, 1955). Basically, a geoboard is a wooden plank in the form of a square. The geoboard is subdivided in a network of equal squares, in the centers of which are planted nails. With elastic bracelets, preferably in different colors, one can represent segments, lines, angles and various polygons and discover or illustrate basic geometrical properties. In *M&P* 15, Pedro Puig Adam exemplified the use of the geoboard by a proof of Pick's theorem, a simple formula for calculating the area of a polygon in terms of the number of nails located in the interior and the number of nails on the boundary of that polygon (Puig Adam, 1958). In quite a long article published in *M&P* 19, Gattegno himself explains how individual geoboards of different sizes can be used in basic and more advanced lessons on geometry (Gattegno, 1960).

Another teaching aid that emerged at the math educational scene of the 1950s was the mathematical film. The basic idea was again that intuition should precede logic and proof. Jean Louis Nicolet, a pioneer in the domain of mathematical films, summarized his philosophy quite concisely: "*Logic proves, but does not convince, intuition convinces, but doesn't prove*" (Nicolet, 1954, p. 24). The films by Nicolet, entitled "*animated geometry*", were short, silent hand-animated films presenting simple geometrical situations, but provoking reflection (Gattegno, 2007). Also math educators from other countries produced mathematical films, e.g. Lucien Motard in France and Trevor Fletcher in the UK. Nicolet and Fletcher were active members of CIEAM in the 1950s as well, so it may not surprise that their ideas were disseminated through *M&P* and that their films were already projected and discussed at the Society's first conference in 1954. Fletcher's films illustrated properties of geometrical curves, such as epicyloids and hypocyloids, topics typically not belonging to mathematical programs in the UK at that time. Fletcher showed himself quite ambitious about the potentials of the new medium:

> It is not only a matter of producing films that illustrate the mathematics as it is taught today. By making films, we will create new mathematics, and if the films are of a sufficient quality, they will change the mathematics that will be taught in the future. (Fletcher, 1954, p. 29.

During the 1950s, many other articles referred to new teaching aids in mathematics, several of them addressing the role of the upcoming computers at that time. Because the international interaction in the computer debates was limited, we will not discuss these contributions here.

MODERN MATHEMATICS

At the end of the 1950s and in the 1960s, several articles in *M&P* dealt with new content for school mathematics – sets, relations, logic and structures – and corresponding teaching methods, e.g. Venn and arrow diagrams. As Servais himself was much involved in the international movement towards the reform of mathematics

education, the new math became a central focus of the journal. Most of these articles were written by Belgian scholars, with Georges Papy (1920-2011) as their uncontested leader. A main theme was related to the development of new (experimental) programs for the subsequent years in which modern mathematics would be introduced (see, e.g., Papy, 1961, 1962, 1966).

The attention giving in *M&P* to the activities of CIEAEM documents the evolution of the Commission in the years preceding the major reforms in the European countries. The report on CIEAEM 17 (Digne, France, August 1963), convened for the first time under the presidency of Papy (Nachtergaele, 1964), showed a clear shift in the Commission's tradition. The aim of the meeting was "*A reconstruction of mathematics teaching for age 10 to 18*". Under the strong leadership of Papy and his French fellow-thinker André Revuz (1914-2008) the Commission agreed upon a concrete list of topics that pupils should have acquired by the age of 16 (published in *M&P* 25, pp. 86-89, as an annex to Nachtergaele's report) (Bernet & Jaquet, 1998).

But the unanimity within the CIEAEM community was less strong than it initially looked... Already in *M&P* 28 one could become witness of a vehement disagreement between Dieudonné and Choquet, two founding members of CIEAEM (Bernet & Jaquet, 1998), about the most adequate axiom system to be chosen for the teaching of geometry at the secondary level (Revuz, 1965). Dieudonné approached the "Euclidian structure" as a "professional mathematician". Central in this approach were the axioms of a vector space of finite dimension over the field of the real numbers, equipped with a scalar product (Dieudonné, 1964). In contrast, Choquet showed more awareness of the pupils' pedagogical evolution and built an axiom system that tried to reconcile mathematical rigor with the pupils' geometrical intuition (Choquet, 1964). Dieudonné launched a violent attack on this more realistic system proposed by Choquet. In the *Introduction* to his book *Algèbre linéaire et géométrie élémentaire*, Dieudonné argued that Choquet's system demonstrated "*a remarkable ingenuity which shows the great talent of its author, but that he considered as completely useless and even harmful*" (Dieudonné, 1964, p. 17). Revuz tried to reconcile Dieudonné's and Choquet's points of view. He defended Choquet's system as an "intermediate step" between pupils' intuition and the "good" (linear algebra based) system proposed by Dieudonné.

> However, if one believes that geometry is not only a mathematical theory, but also a physical theory, if one thinks that the role of education is not only to know mathematics, but also to learn to mathematize reality, one can think about Choquet's system as an intermediate step, which will not only allow teachers to change their mentality, but perhaps also will enable any student to move easily from the intuitive space to the mathematical theory. (Revuz, 1965, p. 76)

On the initiative of Revuz, the disagreement between Dieudonné and Choquet was officially settled at CIEAEM 19 (Ravenna, Italy, April 1965) with a motion about the role of geometry in the education of 10-18-year old pupils, agreed by all CIEAEM members present (but in the absence of the two disputants). In this motion, also referred to as the "Convention of Ravenna" (Félix, 1985), the special place of

geometry in mathematics education was recognized. More concretely, an approach in two stages, inspired by Papy's experiments at the *Centre Belge de Pédagogie de la Mathématique*, was recommended. The Convention was proposed to and solemnly signed by Dieudonné and Choquet at a Seminar organized by the *International Commission on Mathematical Instruction* (ICMI) in Echternach (June, 1965). The "Treaty of Echternach", i.e. the Ravenna Convention with the addition of Dieudonné's and Choquet's signatures, was fully published in *M&P* 28 (pp. 78-81).

Among the rare articles in *M&P* by non-Belgian math educators that were openly in line with the new math approach, we mention a quite long article by the German math educator Hans Georg Steiner (*M&P* 30) on the introduction of the group concept and on computation in groups for 13-14-year olds (Steiner, 1966). Starting with numerous examples of magmas, i.e. sets equipped with a closed binary operation, both in algebraic and geometric contexts, Steiner shows how pupils can work with groups at an elementary level, but meantime opening paths to more general aspects of group theory.

DIFFERENT VOICES: BUNT, FREUDENTHAL AND KRYGOWSKA

Although the new math steam was dominant in the debates that were voiced in *M&P* during the late 1950s and early 1960s, some significant non-Belgian contributors offered a counterbalance. We end this paper by discussing in some detail the contributions by Luke N. H. Bunt and Hans Freudenthal (the Netherlands) and Anna Zofia Krygowska (Poland).

Bunt (1905-1984) was a pioneer in the field of statistics education in the Netherlands. Since 1951 he coordinated a project of the Pedagogical Institute of the University of Utrecht on the teaching of probability and statistics at secondary school departments that prepared pupils for further studies in the social sciences (Zwaneveld, 2000). He was also the author of a textbook on statistics (Bunt, 1956) that was widely used in the Netherlands until the mid-1970s. At the international level, Bunt was a respected scholar too. He was one of the founding members of CIEAEM (Bernet & Jaquet, 1998) and played a main role at the famous Royaumont Seminar (1959), both as an invited speaker and as a co-editor of its proceedings *New Thinking in School Mathematics* (OEEC, 1961), the official report of the Seminar (De Bock & Vanpaemel, 2015).

In *M&P* 17 Bunt reported on the course on probability and statistics he developed with a team of six mathematics teachers and with which he experimented in the alpha streams of Dutch secondary schools (Bunt, 1959). Bunt's didactical approach was rather classical, in sharp contrast with the new math philosophy. First, as mentioned, his target group was different. While most new math protagonists focused on those mathematically gifted students that would become mathematicians or engineers, Bunt aimed at future students in economics, psychology and other social sciences. But he argued that not only these students would profit from such an introductory course, but *all* students because, in the end, every citizen will come in contact with statistical

concepts and methods. A second feature of Bunt's approach that contrasted with new math approaches, is his "pragmatism". Bunt deliberately started with *provisional* definitions, definitions that are *not* completely correct from a scientific point of view. E.g., he would at first define the probability of an event as the ratio between the number of favorable and the total number of possibilities. Based on that definition, he would then prove the main calculation rules for probabilities. Later on in his course, when the need arose, Bunt would present a new definition, covering more situations, based on the limit of relative frequencies, and, without further explanation, he would state that "*for probabilities based on this new definition, the previously proven calculation rules remain valid*" (p. 38). As a consequence of his pragmatism, Bunt was able to arrive in a limited number of lessons at the basic ideas of hypotheses testing, assessing the characteristics of a population on the basis of a sample.

The Dutch mathematician and mathematics educator Hans Freudenthal (1905-1990) needs little or no further introduction. Freudenthal was on good personal and professional terms with Servais, although their ideas sometimes diverged (La Bastide-Van Gemert, 2006). In 1958, in the margin of the World Exhibition in Brussels, Freudenthal was invited to give a lecture at the Society's conference. The topic of his talk was the human responsibility of the mathematician (Freudenthal, 1958). The general tenor of Freudenthal's lecture was philosophical rather than practical. Freudenthal stated that the responsibility of the mathematician goes further than creating and transmitting formulas that others can apply. In his view, there is something he called a "mathematical mind".

> … there is a mathematical mind that – I'm convinced of it – will not only determine the character of our relations with the physical world and with the machines we construct, but also our human relations – individual, international and interracial. Rationalization of these relations is a mission we have to fulfill in the remaining years of the XXth century. The rationalization of something is a mathematician-specific activity or at least an activity of the mathematical mind. (Freudenthal, 1958, p. 40)

According to Freudenthal, mathematicians are educators of humanity, even if they dedicate themselves to the most abstract mathematics. They work for a future in which reason will be the regulator of human relations and through their work, they fulfill their human responsibility. Although Freudenthal did not talk about contemporary problems in math education, his invitation at a Society's conference and his collaboration to *M&P* reflects an openness among Belgian mathematics teachers to the ideas of other mathematicians than those belonging to the French structuralist school.

Also Anna Zofia Krygowska (1904-1988), eminent teacher, teacher trainer and scientist in mathematics education, belonged to Servais' network within CIEAEM. Krygowska became active in CIEAEM during the 1950s and soon developed into one of its driving forces. Krygowska became the Commission's vice-president under Papy's presidency (1963-1970) and, in delicate circumstances, after Papy had left the Commission in 1970, she accepted to become president (until 1974). It was the beginning of a new period in the history of CIEAEM in which also Freudenthal

assumed a more prominent role and in which "problem-driven education" became the central theme of discussion (Bernet & Jaquet, 1998).

Krygowska wrote no less than four articles for *M&P*, articles that are quite long and thoroughly elaborated. In her first article, published in the section *Knowledge of the pupils*, Krygowska warned for the dangers of formalism and verbalism in the teaching of algebra (Krygowska, 1957). She discussed a large number of systematic errors made by pupils which were not yet an object of systematic study and reflection at that time. Krygowska tried to understand these errors and to unravel the underlying mechanisms. In a second article, Krygowska pointed to a number of misunderstandings in pupils' thinking due to the tension between the formal definition of a geometrical concept and pupils' intuition about that concept, related to its representation and often resulting from a long evolution (Krygowska, 1959). In a third article, Krygowska intervened in the debate about the place of geometry in a unified mathematical framework. Instead of abandoning geometry as an autonomous mathematical discipline, she saw geometry as one of the ways to arrive at a unified mathematics (Krygowska, 1962). Finally, Krygowska held a plea for the need of a strong pedagogical concept for the reform of mathematics education. She stated: *The pedagogical concept of "mathematics for all", adequate to the role of mathematics for integrating the world of today and tomorrow, is still in its infancy*" (Krygowska, 1964, p. 39).

CONCLUSION

During the 1950s and 1960s, the *Belgian Society of Mathematics Teachers* and its journal *M&P* flourished. Due to Servais' dynamism and network within CIEAEM, major scholars of that time, coming from different European countries, contributed to *M&P* and used the journal to express their views about how mathematics teaching and learning could be improved. This paper has demonstrated that *M&P* is a rare and important source for the study of the European history of mathematics education during the 1950s and 1960s, a period in which only few professional journals on math education were available.

NOTE

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