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The International Commission on Mathematical Instruction

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Legend: IMU stands for *The International Mathematical Union*.

Editorial

This issue of the ICMI Bulletin is the last under my editorship. As indicated elsewhere in this Bulletin, a new Exceutive Committee of ICMI takes office as of the 1st January 1999. This implies that the position of Editor will assumed by the new Secretary of ICMI, Professor Bernard Hodgson, from that date. So, on future matters concerning the Bulletin, please contact

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I should like to use this opportunity to thanking all contributors to this Bulletin during the eight years I have enjoyed the privilege of being its editor. I further want to thank Mrs. Inger Margrethe Christensen, at my department, who has been the Secretary of the Secretary of ICMI throughout my two terms and has been of invaluable assistance in several respects, including to the production and distribution of the Bulletin. I also want to thank my two sons, Henning and Martin, who have assisted me greatly in the technical preparation of the Bulletin over the years. Finally, my thanks go to my university and my department which have sponsored the printing and the posting of the Bulletin from the beginning to the end.

It is with great pleasure and comfort that I pass on the editorship to my successor Bernard Hodgson. It will be difficult to imagine a better editor. I wish him the very best of luck and pleasure in producing the ICMI Bulletin in the years to come.

Mogens Niss
Secretary of ICMI and Editor of the Bulletin 1991-1998

New Executive Committee of ICMI

On the 31st of 1998, the term of the present Executive Committee of ICMI comes to end end. A new Executive Committee of ICMI, appointed by the General Assembly of the International Mathematical Union (IMU) in Dresden, Germany, 1998, assumes office on the 1st January 1999. The new EC has the following composition:

> *President*: Hyman Bass (USA)
> *Vice-Presidents*: Nestor Aguilera (Argentina); Michèle Artigue (France)
> *Secretary*: Bernard Hodgson (Canada)
> *Members*: Gilah Leder (Australia); Yukihiko Namikawa (Japan); Igor Sharygin (Russia); Wang, Jian Pan (China)
> *Members ex officio*: Miguel de Guzmán, Past President, (Spain); Phillip Griffiths, Secretary of IMU (USA); Jacob Palis Jr., President of IMU (Brazil)

The outgoing EC wishes the incoming EC all the best of luck and progress in its work for mathematics education.

Mogens Niss

Donation from Korea to ICMI

The Korean Sub-Commission of ICMI has decided, in continuation of the successful completion of the First ICMI East Asian Conference on Mathematics Education, ICMI-EARCOME-1, to make a donation of US$ 1.000,00 to ICMI. The Executive Committee is very grateful for this generous step and wants to thank the Korean Sub-Commission for its generosity.

Farewell Message from the Outgoing President and Secretary

Miguel de Guzmán and Mogens Niss

On 1st January 1999 the members of the new Executive Committee of ICMI, elected in Berlin last August by the General Assembly of the IMU, will start their term. For all the members of the outgoing Executive Committee is an honour to be succeded by persons as eminent as the members of this new team. For us, in particular, it is a pleasure to be substituted in our respective positions by collegues as qualified in the fields of mathematics and of mathematics education as Hyman Bass and Bernard Hodgson, the new President and the new Secretary, respectively. We are certain that they will be able to perform, with great efficiency, the tasks of which the international mathematical community has appointed them to be in charge.

We would like to use this opportunity first of all to thank, in our own name and on behalf of the International Mathematical Union, - and thus on behalf of the whole international mathematical community - for the magnificent work of collaboration done by all the members of the two successive Executive Committees with which we have had the pleasure to work during the past eight years. The constant spirit of understanding and collaboration has made the task of all of us very pleasant and, we hope, also reasonably fruitful.

We further wish to recall with thanks the continued and enthusiastic collaboration of the groups affiliated to ICMI, of the National Representatives which whom we have been in contact, of the different national subcommissions of ICMI, and of the many people who have served on the numerous committees that have been working so efficiently to organize the many congresses and meetings of all types which have been held under ICMI auspices, such as the ICMEs, the ICMI Study Conferences, regional meetings, and so forth. We also would like to thank the many national mathematical societies, of different kinds, which have offered their continuous help in the organization of a multitude of events contributing to the ever expanding activities concerning mathematical education. The list of individuals and organizations that have contributed to ICMI related activities during the past eight years would be very long indeed. To all of them we here extend our sincere thanks.

We wish to use this occasion to briefly present our reflections with particular regard to some of the main activities in which ICMI has been engaged during the two terms of our offices. We think this may be useful in order to explore possible further developments of ICMI in the future.

During this period ICMI has experienced a considerable expansion in many different respects. The number of Member States has increased from 59 to 72 and is still increasing. But, even more importantly, the organization in different countries of the ICMI Subcommissions has proven to be a very efficient instrument for strengthening the ties of the different countries with ICMI. In our opinion, this might well, in the future, serve as the ordinary structure of connection between each of the Member States with ICMI, more operative and reliable than the single person delegations which has been the tradition for a long time. The experiences with the organization of the national ICMI Subcommissions in some countries could serve as models or sources of inspiration for other countries where the old way of representation is still in use.

It has been our constant intention throughout our terms to try and make of ICMI a truly international organization, in which the traditional influence and dominance of specific cultures in the field of mathematical education could be balanced with a healthy development of initiatives and activities in countries which, until recently, had only limited opportunities to establish this field as an important focus of attention. The last two Executive Committees have made a serious effort to look for new places and new countries in which different activities related to mathematical education could be set up, as well as for new people to serve on the different bodies charged with the organization of such activities. We think that this policy has been and will continue to be rather fruitful for the future of mathematical education in the entire world, even if the pursuit of it might, from time to time, run the risk of not achieving all the ideal goals if viewed from the perspective of some established quarters. We have tried to achieve the goal of broadening the scope and platforms of ICMI related activities through a careful choice of the venues of congresses and meetings organized under ICMI's auspices, and through a balanced selection in all regards (to the extent this was within reach of the ICMI EC) of the persons involved in the organization of such meetings and events.

During our terms a considerable amount of efforts has been invested in continuing the lines of action initiated during the 80's by the previous ECs, under the leadership of Jean-Pierre Kahane and Geoffrey Howson, concerning the ICMI Studies. These studies, each of which includes a correponding ICMI Study Conference, have become essential instruments for ICMI to influence the trends in mathematical education. The foci of attention of these studies have been greatly expanded, now ranging from studies with a socio-educational component, such as "Towards Gender Equity in Mathematics Education", to content-oriented ones, such as the "Perspectives on the Teaching of Geometry in the 21st Century", and including studies related to research in mathematics education, such as "Mathematics Education as a Research Domain: A search for Identity", to mention only the most recent completed studies. A remarkable expansion of the action of ICMI is represented by the two ongoing studies on 'The Role of the History of Mathematics on the Teaching and Learning of Mathematics", and on "Teaching and Learning of Mathematics at University Level". One can rightly say that the ICMI Studies have become a place of reference for the whole mathematical community.

The field of influence of ICMI has become manifest also through the continuously increasing number of participants in the quadriennial International Congresses on Mathematical Education (the ICMEs), one of the most important activities of ICMI. At ICME-6 (Budapest, 1988) there were about 2500 participants, at ICME-7 (Québec, 1992) about 3300, and at ICME-8 (Sevilla, 1996) their number was close to 4000. But even more important and satisfactory than the number of participants is, in our opinion, the fact that the number of participants from many countries which until recently were not represented at all in events like the ICMEs, has increased considerably increased. This was, for instance, a very remarkable feature of ICME-8.

One reason why this has been made possible is the impact of the Solidarity Program and Fund for Mathematical Education set up by the EC at the time of the ICME-7 (Québec, 1992). The response of many individuals and of numerous mathematical societies and other organizations from different countries has been a model of a true spirit of international solidarity. We believe that this line of development may be one of the main tasks of ICMI to pursue for the future. Although some activities have already taken place under the umbrella of the Solidarity Fund, it seems to us that the Solidarity Program has far from reached its ceiling, and it will be necessary and worthwhile to look for imaginative ways to develop its field potential. In this respect, the incoming EC has an important task to face.

There is a particular point with which the outgoing EC feels rather satisfied. It is fairly obvious that the work done by ICMI, in cooperation with the organizations that has collaborated with it, has enjoyed increasing acknowledgement within the mathematical community at large during the last decades, particularly so by people working in mathematical education. A testimony of this recognition is the increasing number of requests by a variety of mathematical organizations to obtain some kind - mostly just moral - support from ICMI. To be related to ICMI some way or another has become a sort of seal of guarantee of solidity and quality in mathematical education.

Of course we would not want to claim that there has been no problems and difficulties during our terms. In fact there has - of course - been several minor and also a few major problems. But there is one particularly serious problem that we would like to comment on in some detail. It probably has to do with the degree of complexity that mathematical education and the mathematical community have now reached, and we feel that, in spite of the efforts of the present and the past ECs, we have not been able to cope with the problem in a satisfactory way.

The mathematical community is now a rather heterogeneous world. Within it, several different subcommunities and subcultures co-exist whose views on mathematical education sometimes do not agree, sometimes even strongly disagree. So, their relationships are not always as smooth as one would have wished them to be. First of all there is the immensely numerous group of teachers and professors at all levels who are directly responsible for tasks connected with the teaching of those aspects of mathematics which are currently considered the most appropriate ones to be learned. Then there is the large group of mathematicians engaged in the development and application of mathematics as a scientific discipline, either at universities or at other centers, institutions, organisations and companies. In recent times the very complexity of mathematics education has given rise to the emergence of a large group of people who devote themselves to the scientific and scholarly investigation of problems in mathematical education. Of course one could distinguish other groups of people engaged in different tasks within the mathematical community. Such distinctions do not exclude an individual from being members of several different groups at the same time. Many of us are.

Especially at times of transition, reform and lack of clear definitions regarding the best ways to bring about mathematical education, many different points of view related to the diverse situations and problems that mathematical education is confronting do arise, and have to arise. To these differences in view correspond, in a natural way, tensions not only between individuals but also between the different mathematical subcommunities. The life of ICMI, as a commission for mathematics education within the IMU, has been affected in significant ways and extents in the past by such conflicts and tensions, and may continue to be so in the future, unless we are all able to take appropriate measures to counteract them. We are convinced that it will be very important for the future of mathematical education in the whole world that mutual respect and a deep sense of collaboration amongst the different individuals, quarters and subcommunities of mathematics be reached. This should lead to an appropriate and effective balance of influence in the process of taking important decisions. In our view we have not yet reached an ideal state in this respect, and we sincerely hope that the incoming Executive Committee will be able to lead the mathematical community dealing with the problems of education closer to such a state.

As a final and personal remark we, the outgoing President and Secretary, would like to emphasize that for both of us this eight year period of intensive work and dedication has been extremely pleasant and rewarding thanks to, among other things, the high degree of communication and mutual understanding between the two of us. Through our deep and continuous cooperation we have been able to confront many problems and periods of heavy work that could have been too strenuous in other circumstances. We wish for our successors that they will succeed in developing a similarly profund, rewarding and pleasant working community and friendship.

We leave full of confidence that the leadership of ICMI will be in very competent and skillful hands in the next term(s), and we have no doubt that ICMI's course in the future will be extremely fruitful for the whole mathematical community and its subcmmunities.

Miguel de Guzmán, President **Mogens Niss**, Secretary

Math War Developments in Califonia - Another Perspective

Henry L. Alder

Introduction
In [1], Jerry Becker and Bill Jacob [B&J] reported on the "Math War Development in the United States (California)" from their particular perspective. This they did by including facts that supported their opinions and omitting those that did not. It is the purpose of this article to supply some - but by no means all - of the essential facts missing from their article in order to enable the reader to form a more balanced view of what is widely referred to as the "math war in California."

My perspective derives from having served, as did Bill Jacob, on the 1997 mathematics framework committee (see paragraph 1 of page 18 of B&J), being a professor of mathematics at the university of California, Davis, having served as president of the Mathematical Association of America (MAA), a member of the California State Board of Education (SBE) from 1982 to 1985, and a member of numerous other committeess concerned with mathematical education at the state, national, and international levels.

Background
As stated by B&J (see last paragraph of page 17), "by the summer of 1995 the verdict was clear, the 1992 Mathematics Framework (MF) had failed." This verdict was arrived at among others by the numerous parent groups that had organized themselves in many California cities in opposition to what they perceived as the damaging results of the 1992 MF on the mathematical education of their children. The most active of those parent groups were those of San Diego and Palo Alto. They called themselves "Mathematically Correct" and H.O.L.D., respectively. Others, such as Q.E.D. in Santa Barbara, were equally strong in opposition to some of the reforms advocated in the 1992 MF. Most of these groups include primarily scientists with some - but relatively few - mathematicians. Their leaders include biologists and political scientists, the latter primarily because they know how to get organized effectively and to deal with the media.

The verdict was, however, also shared by many prominent mathematicians in California. Some of these had strongly advised the SBE not to approve the 1992 MF at the time it came before that board for action.

As a result of this widespread dissatisfaction with the 1992 MF, California Superintendent of the Public Instruction Delaine Eastin appointed in April 1995 a "California Mathematics Task Force" (CMTF) to address the need to improve the mathematics achievement of California students. Her message was clear and emphatic. She called for action:

"Let's do what needs to be done to turn education in mathematics around - to prepare all of California's

children for success in the future by providing them with the knowledge and skills they will need. And let's do it now."

Two co-chairs were appointed to lead the CMTF. Surprisingly, one of them was them same person who is identified in the 1992 MF as having directed the development of its final stages. In September 1995 the CMTF issued its recommendation in a document "A Call to Action: Improving Mathematics Achievement for All California Students" [2] containing five major recommendations, the first one of which is the following:

"The State Superintendent of Public Instruction must act immediately to establish clear and specific content and performance standards for mathematics and to work with districts and schools to make the standards achievable by all students."

This recommendation clearly called for a revision of the 1992 MF whose lack of "clear and specific content and performance standards" and of an appropriate balance between basic skills, conceptual understanding, and problem solving had been the cause of so much of its criticism. Indeed, the SBE was deeply concerned about this when it sent, jointly with the State Superintendent of Public Instruction and the California Commission of Teacher Credentialing, a "Mathematics Program Advisory" in October 1996 to all school superintendents and principals advising them that "the Mathematics Framework will be revised during 1997 with adoption by the State Board of Education scheduled during 1998."

A New Mathematics Framework

In August, the California Curriculum Commission (CC) recommended to SBE the appoinment of 15 members for a new Mathematics Framework Committee (MFC), to revise the 1992 MF in accordance with the recommendations of the CMTF and the Mathematics Program Advisory. The CC was, of course, required to choose these members from those who had submitted formal applications to serve on the MFC. 94 such applications had been received. The CC unfortunately selected for its nominations - with only one exception - only persons who had been involved in preparing the 1992 MF or were well known to be strong supporters of it.

The SBE, therefore, had no choice but to reject many of these nominations. The Board felt that such a Committee needs to contain a proper balance of members known to be supportive of the 1992 MF, those known to have substantial reservations about that Framework, and those who had not expressed any opinion on the matter. Accordingly the SBE appointed 8 of those recommended by the CC and chose 14 others by carefully reviewing the qualifications of those who had submitted formal applications for the position. By regulations, more than half of the MFC must consist of K-12 teachers of mathematics. Many of them had received awards for the excellence of their teaching. Among the other members of the Committee were representatives from all involved and interested constituencies (most of whom were not represented on the CC-recommended Committee), such as mathematics departments of the California State University System (which prepares the vast majority of teachers in California and had not a single representative among the CC-recommendations), the University of California, Stanford University (in fact the Committee included the current or immediately preceding chair of the mathematics departments of Berkeley, Stanford, and Davis), schools boards, parent organizations, scientists using mathematics, etc. The decision of who should chair the Committee was left for the Committee itself to make by secret ballot. The Committee selected Deborah Tepper Haimo, who has held many positions of leadership including the presidency of the MAA. In addition, she had only recently moved to California and was, therefore, not identified with any of the views on mathematical education in California.

Since B&J report "an elimination of all discussion of pedagogy" from the MF draft, it should be noted that the MFC agreed to soft-pedal pedagogy and emphasize content as one of the frequently voiced objections to the 1992 MF had been its strong advocacy of one particular teaching strategy without any clear evidence that it is the most effective one in all situations. This decision also resulted from the desire on almost everybody's part to give teachers as much freedom as possible to use the teaching strategies they deem most effective for their individual circumstances. The MFC, however, urged a balance in the use of several possible instructional strategies in its draft which also included a description of properties of a good lesson.

As reported by B&J, "in 1997 the framework committee met, developed and sent a draft to the CC with all eight CC-recommended framework members voting against it." Not reported there is the fact that, of the 14 additional members appointed by SBE, 13 voted for it and 1 against so that the draft was approved by a vote of 13 to 9.

The draft was then sent out for field review with 2,000 copies sent to country offices of education, school districts, universities, and mathematics experts and 300 individuals who requested a copy. Reviewers generally supported most parts of the framework "as they marked very good/good over 50% of the time for chapters I, II, III, IV, V, VII, VIII, X, XI, XII, Appendices B and C" (a quotation from the Field Review Results, prepared by the CC). That chapter VI (Curriculum Content) did not enjoy full support is not surprising. The MFC knew that it would have to be rewritten after the school mathematics (K-12) standards would become available (which they were not at the time the draft was completed by the MFC) and, therefore, did not develop that chapter with the same care as it did the others.

The California Mathematics Standards

As reported by B&J (see page 17, paragraph 2), "Standards are new to California." They were developed by a "Standards Commission" (SC) that completed its work in September 1997 and sent its draft for action to the SBE. The SC included only one member with any expertise on mathematics, a middle school mathematics teacher.

Public hearings on these draft Mathematics Standards were held. All mathematicians present at the public hearing I attended on October 20, 1997, in Sacramento, without exception, gave testimony why these Standards in their present form were completely unacceptable. Accordingly, the SBE asked a group of mathematicians, mostly from Stanford University, to revise the Mathematics Standards to address the concerns made known at the public hearings. This revised draft was approved unanimously by the SBE in December 1997. As a former member of the board, I note that it is rather unusual for any action by the SBE to be approved unanimously.

When a few teacher educators in California raised strong objections to the Mathematics Standards approved by the SBE, an open letter to them was prepared from which the following is a brief quotation:

"We urge you to recognize the important and positive role California's recently adopted mathematics standards can play in the education of future teachers of mathematics in the State of California."

This letter was signed by more than 100 mathematicians from California's institutions of higher education including the chairs of the mathematics departments at Stanford, California Institute of Technology, the Irvine and Riverside campuses of the Univeristy of California, The California State University at Los Angeles, The Vice President of the American Mathematical Society, etc. Many mathematics teachers at the elementary and secondary level, including Jaime Escalante, added their personal endorsement of this Open Letter.

Perhaps more important than these favorable statements about the new California Mathematics Standards is the document "State Mathematics Standards: An Appraisal of Math Standards in 46 States, the District of Columbia, and Japan," by Ralph. A. Raimi and Lawrence S. Braden, commissioned by the Thomas B. Fordham Foundation. While this booklet appears in the list of references of the article by B&J, no mention of it is made in the body of that article. The following is a brief description of its contents: The report represents a detailed analysis of all mathematics standards that were available, 47 in all. Grades of A, B, C, D, or F were given to each state, based on an analysis of the contents according to criteria and grade levels described early in the report. The highest score possible was 16.0, which only California received, Japan was next with 15.0, followed by North Carolina with 14.2 Only threes states received a grade of A, and just nine others a grade of B, seven a grade of C, twelve a grade of D, and sixteen a grade of F.

Conclusion

B&J conclude: "Perhaps we can see that the California 'math wars' have in their final analysis, served a useful purpose." I certainly agree. Just think for a moment where California mathematics education would be now without this war. The National Assessment of Educational Progress in which California ranked 41st out of 43 states, would likely rank it at its next administration at the bottom of all states. More importantly, the math wars in California have forged a very strong coalition among the many constituencies with a vital interest in a significant improvement in mathematics education in California, most notably mathematicians, teachers, parents, and members of the SBE. If this strong coalition can be preserved once the war has ended, the future of mathematics education in California looks bright indeed, and developments in California can serve as a model for other states and even nations who wish to advance their mathematics education significantly.

Acknowledgement

This article has benefited greatly from valuable suggestions made on an earlier draft by Ruth Asmundson, Deborah Tepper Haimo, Martha Swartz, and Voula Steinberg.

References

[1] Jerry P. Becker and Bill Jacob, *Math War Developments in the United States (California)*, The International Commission on Mathematics Instruction, Bulletin No. 44, 1998.

[2] *California Department of Education, A Call to Action: Improving Mathematics Achievement for All California Students*, Sacramento, California, September 1995

[3] Ralph A. Raimi and Lawrence S. Braden, *State Mathematics Standards*, Thomas B. Fordham Foundation, March 1998.

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Response to Henry Alder

Jerry P. Becker and Bill Jacob

We are pleased that Prof. Alder has read our article and provided some additional details about the "debate" in California. In our view, however, he chose to merely describe a few events. We do not believe his discussion sheds significantly more light on the dynamics surrounding the controversy. Prof. Alder listed areas of agreement, but seems to avoid discussing the core and problematic issues identified in our article - these include the issues of: (1) what balanced standards actually are, (2) the exclusive reliance on behaviorist research and the direct linkage of state policy to this one-sided view of education, (3) the State Board's practice of circumventing public review of documents prior to major decisions as required by state law. For example, the SBE's use of gross misinformation in an important instructional materials adoption in September, 1997.

Alder mentions two important state documents - the CMTF's "A Call to Action" and the SBE's "Mathematics Program Advisory". Two key recommendations in these documents are calls for "clear and specific content and performance standards" and a "balance of basic skills, conceptual understanding, and problem solving" in California mathematics education. Both of these recommendations have wide support in California; for example, the public discussions of the Mathematics Framework Committee during 8 months of 1997 give ample evidence, in our judgement, that striving for balance and clearly articulated standards is a goal shared by all. The controversy, however, arose when the parties began the real work of trying to bring some specificity to the ideals of "high standards" and "balance". In our article, we illustrated the nature of the discussions by citing specific examples provided by those with different views (see pp. 20-21). In response, Alder does not seem to offer anything specific. Instead he presents general discussion and some history about the need for clear and high standards - it is our hope that the reader will not erroneously infer that one camp supports high standards, while the other does not. On p. 19 we note that "The press seemingly never examines why both sides claim their views represent 'high standards'." We note that Alder has seemingly also chosen to avoid this issue.

We noted (p. 18) how the processes used by the SBE of making substantial last minute policy reversals using documents withheld from public inspection has inflamed the controversy. On p. 18 we cite two examples (there are more, in our opinion) from a memo presented by Janet Nicholas to the SBE on September 9, 1997, where in a few minutes the Board reversed a recommendation to approve two Dale Seymour programs for adoption (also see [J, 1998]. Nothing is more important than providing high-quality instructional materials for teachers, yet the SBE acted hastily using blatant misinformation. Yet Prof. Alder does not comment on this central issue - perhaps because members of the parent H.O.L.D. group, mentioned by Alder, presented Mrs. Nicholas' documents to the Palo Alto School Board in April 1998 (which included her number theory "error" that "30 does not divide 36x45") in a campaign to dissuade them from choosing the Dale Seymour materials. After careful consideration of the actual documents, the Palo Alto School board adopted the Dale Seymour materials (by a 4 to 1 vote), even though state monies for their use were not available.

The Standards revision was produced by four Stanford University mathematics professors, and the SBE accepted their work in December without significant public input or consultation with K-12 teachers or mathematics education faculty. As we noted (p. 18), the Commission's draft of the Standards was hastily assembled and "both sides of the debate criticized and worked to correct" it. However, we wonder if Alder wants the reader to believe that the flaws in the Commission's document necessitated the one-sided consultation, only by research mathematicians, and that those critical of the SBE action somehow were in favor of the problems with the Standards. There were many critics of the SBE action and they felt that the revisions - had lost balance in favor of automatic skills (and therefore lowered standards by short changing conceptual understanding), and that the revision's wording doesn't communicate well with teachers and parents. The only way to develop an informed opinion is for readers to compare these two documents side-by-side. In our paper, we discussed specific examples, while Alder seems to offer vague references to letters by research mathematicians aligned with one side, and a report by the Fordham Foundation whose criteria are not given; moreover, we wonder about the status of the Fordham Foundation regarding educational matters in mathematics education in the United States.

The Mathematics Framework is another instance where the SBE is now substituting documents prepared outside the public process to impose substantial policy changes. Alder notes the agreement of the 1997 FW committee to "soft pedal pedagogy". However, the proposed Framework (latest version released Nov. 23, 1998, see www.cde.ca.gov) shows that the SBE is preparing for quite the opposite - they will demand highly prescriptive drill-and-practice teaching based upon the narrow "research" described in our article (pp. 19-20), and materials adoptions and professional development for California teachers will be tied to this (the latter specified in AB 1331 signed by Gov. Wilson in August, 1998). Much of the new Framework material was prepared by Prof. David Geary at the request of the SBE. The draft by Geary prominently cites the report by Douglass Carnine's group described in our article in his revision of the "Instructional Strategies" chapter of the new Framework. Given that the Chair of the 1997 Framework Committee adamantly refused to allow its members to present (let alone discuss) research in mathematics education as part of its deliberations, the fact that the one-sided approach of the Carnine group will now play a substantial role in California's instructional and materials adoptions will serve only to heighten tensions. California law requires that research be considered in its Frameworks and in instructional adoptions, yet Prof. Alder does not seem to comment on what we consider to be a "back door approach" to addressing this central and important issue.

Significant is the "Grade-level emphasis and instructional profiles" section in Geary's draft of the Framework, which details K-6 research-based instructional approaches. For example, the entire page and a half 3rd grade "Elaboration" does not contain any information going beyond rote mastery of symbolic procedures for number calculation. There is also a 22-page supplement for 7th grade teachers that details exactly how to teach compound interest, now a major area of skill emphasis in California. It's first sentence reads "Real applications of mathematics at the seventh grade are hard to find." In September, the Curriculum Commission added to Geary's original grade level commentary bulleted items under the title "Some of the key concepts that underlie the Standards at this grade are:", but all of these were deleted by the SBE in its Nov. 23 version. An entirely new Framework section "Special Considerations for Mathematics Assessment" has been added since the Oct. 13 version was released. Its emphasis is on "timed tests" to measure speedy recall of facts and procedures. One of its paragraphs reads:

"The level of knowledge of basic topics required for students to advance further requires that they be mastered to the level of automaticity. Consequently the best method for assessing the emphasis topics is the timed test."

This illustrates how willing this (unknown) Framework author is to ignore the importance of thoughtful problem-solving and conceptual questions as integral to balanced assessment. Anybody who studies this publicly-presented draft of the Framework will see that in spite of the claims to the contrary in its Introduction, California has now mandated an extreme back-to-basics approach that we believe will not enhance students' conceptual growth. The SBE vote on the Framework is scheduled for December 10, 1998. (We note that several key sections have not been made public by the November 23 posting of the draft.)

Contrary to the general statements such as those Prof. Alder presents, we believe that the details must be considered. The lack of balance in the California Standards and Framework will likely precipitate more bickering and tension among California mathematics teachers in the years to come - and we are already witnessing this at the present. We referred (p. 23) to the deep divisiveness of the debate over mathematics education reform in California and the nation. What is needed is constructive discourse and mutual respect for the ideas of people on all the sides of the issues. Beyond this, it seems important that the sides in the debate be willing to listen to each other and to work towards a consensus on policy documents that will play a crucial role in determining what educational materials and what teaching practices will characterize mathematics education in the future.

References

Jacob, B. (1998), 'Instructional materials for K-8 mathematics classrooms, the California adoption', 1997, *Issues in Contemporary Mathematics*, edited by E. Gavosto, S. Krantz, and W. McCallum, Cambridge, England: Cambridge University Press (to appear).

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Italian Research in Innovation: Towards a New Paradigm?

Maria G. Bartolini Bussi

Preface

This short essay aims at giving landmarks for understanding a recent trend in Italian research in the didactics of mathematics, which, without exhausting the whole of the research studies produced in Italy, is more and more widely represented in the proceedings of the international conferences and in the main international journals and books. The genesis of this original model of educational research is a matter of historical reconstruction rather than a collection of objective facts (if they exist at all). As such it suffers from the bias of the author's scientific and professional interests. This short paper summarises information, opinions and discussions that have been developed elsewhere. The interested reader is referred to [1], [2] and [4]. The last-mentioned book was prepared on the occasion of the international congress ICME 8 (Seville 1996). It is composed of a wide introduction and of series of essays on specific themes, each of which offers an outline of studies carried out between 1988-1995 on the topic examined, and tries to frame them within the international literature. The volume was not for sale. Some copies are still available. (To obtain one, please contact Marta Menghini (menghini@axrma.uniroma1.it), Dipartimento di Matematica, Università, Piazzale Aldo Moro, 1, I-00185 Roma, ITALY)

1. Introduction

The tradition of an involvement of professional mathematicians in the debate about mathematics education from the very beginning of primary school is very ancient in Italy (see [2] for an historical reconstruction). A crucial episode in this long history is represented by the proposal in 1966-7 of the so-called 'Frascati programs', prepared for secondary school by a mixed group of mathematicians, teachers and government officials, appointed by the Italian Commission for the Teaching of Mathematics, that had been, since 1908, the Italian reference body to ICMI. These programs were not put into practice but influenced all the further development in the field [2].

The desire to realise something in the spirit of these programs, was one of the cultural mainsprings that lead some years later to the institution of the NRDs (Nuclei di Ricerca Didattica - Didactics Research Teams) in several universities. These groups were composed of university professors, operating in Departments of Mathematics, and school teachers, with the aim of renewing the contents and methods of teaching. They had the scientific support of the UMI (Unione Matematica Italiana - the Italian Mathematical Union) and the financial support of the CNR (Consiglio Nazionale delle Ricerche - National Council for Research). In the early years the major effort was directed towards the production of innovative projects to be tested and disseminated, first of all for secondary school and later for all the school grades. The experience that matured in this way was precious and later transposed into the drafting of the new national syllabuses for middle school (grades 6-8) in 1979, primary school (grades 1-5) in 1985, and the first two years of secondary school (grades 9-10) in 1987, thanks to some leading mathematicians who had directed the activity of the NRDs themselves and had been appointed by the Ministry of Education to serve on the national committees. Besides, the tradition of peer co-operation between university professors and teachers was firmly established and influenced very deeply the further developments, leading to an original model of educational research, whose presentation is the main focus of this paper.

2. Research for Innovation: A New Paradigm?

2. 1. The Roots of Research for Innovation

In a paper coauthored with Ferdinando Arzarello [1] we have reconstructed the genesis of this model by means of a conceptual structure that allowed us to identify three distinct research traditions: *concept-based didactics*; *innovation in the classroom*; *laboratory observation of processes*. The arguments of the quoted paper are briefly summed up in what follows.

The first two trends, internal to the Italian tradition, were born in two different places (the university / the school) and carried out by different communities (the mathematicians / the teachers of mathematics); addressed different objects (the teaching of Maths in 'generic' / 'specific' situations); answered different needs (to produce ideas for improving Maths teaching / to produce improvement in Maths teaching); adopted different methodologies (top-down model / action-research); focused on different problems (products / short and long term processes in Maths teaching); and offered different products (textbooks, tests, syllabuses / projects for curricular innovation). Both trends had a long tradition rooted, in the universities, in the activity of many leading mathematicians, from the seminal work of Cremona, Betti, Veronese, Peano, Vailati, Enriques and, in the schools, in the work promoted by spontaneous groups of teachers and teacher associations; some of these teachers (like Emma Castelnuovo) became well known also outside Italy.

In other countries, in spite of the presence of similar traditions, the pressure of academic institutionalisation of didactics as a scientific discipline led to a complete separation between forms of theoretical research (closer to 'concept based research') and forms of action-research (closer to 'innovation in the classroom'). In Italy a different pathway was followed, namely the progressive integration of both traditions. As we have said in the introduction, the small but active groups of university mathematicians interested in didactics and of innovative teachers of mathematics came in touch with each other and started to work together, leading to the constitution of the early NRDs. On both sides, participants were volunteers, driven by cultural and social needs, which placed this cooperative work as an additional activity in their respective institutions.

In the late seventies, several NRDs were working in the Departments of Mathematics at various universities on projects for curricular innovation, with the financial support of the CNR. The grants were used partly to cover the costs of classroom experiments, but the biggest investment was made for researchers (from both university and schools - the latter being named *teacher - researchers*) to allow them to take part in important seminars, conferences, summer schools, symposia, held in Italy or abroad. Some important international conferences were organised in Italy and new ideas started to circulate among Italian researchers. They came in contact with different research traditions, e. g. with the methods of what may be called *laboratory observation of processes* (e. g. in the PME Conferences). It consisted in basic research studies about short term processes, developed around laboratory experiments (where the classroom itself could be used as a laboratory), with analytical tools borrowed from psychology, sociology, pedagogy and so on; the methodology was based on experimental induction, as it is conceived in natural science.

A complementary influence was exerted by the original French paradigm. Some French researchers were invited to Italy and several Italian researchers took part in the French summer schools. One of the points of disagreement was the limited role (if any) that the teacher had in the early elaboration of the theory; that clashed against the system of beliefs matured within the activity of the NRDs. However, the influence can hardly overestimated that the French paradigm had in identifying some points of weakness in the earlier work developed in Italy, on the one side, and, on the other side, in offering a model of a way to transform facts coming from the design and the implementation of classroom activity into phenomena of a didactic theory.

2. 2. *The Need for a New Paradigm*

A need emerged of the necessity to make the didactic dimension of the projects more precise, in order to understand, for instance, why some innovations would work in some classrooms and not in others. For this problem, no tool was available either in 'concept based didactics' or in 'innovation in the classroom'. Researchers became aware that 'laboratory observation of processes' could have furnished suitable tools, but they encountered a lot of problems.

A) The design of classroom experiments

Teachers insistently claimed that long term teaching experiments were the privileged setting within which to study deep changes in the development of mathematical thinking. The habit of planning classroom activities on a long term basis was surely influenced by the institutional constraints of the Italian school system, where a teacher teaches the same group of students for several years. The teachers felt ill at ease with the short term detailed observations of most educational researchers (typical of the 'laboratory observation of processes') that were supposed not to grasp the very important things in the teaching-learning process. Yet, no long term experiment could have been implemented in any classroom without the strong involvement of the teacher: as it was the teacher who had the institutional responsibility for teaching, s/he could have 'lent' her/his classroom for a session (short term experiment), but not for a month or several months. So the teachers had to be active members of the research team already in the design phase.

B) The analysis of classroom experiments

'Laboratory observation of processes' was usually carried out by detached external observers on the basis of carefully designed protocols. Also in the French paradigm, the role of the detached observer was emphasised. No contradiction was found when the object of observation were processes with the individual pupil, but when the object of observation were classroom processes, the teacher was to be observed together with pupils. Several analytical studies had been developed outside Italy and had highlighted the presence of hidden patterns and routines in classroom interaction which sometimes had the effect of being in contrast with the teacher's aims, against his/her will. These results were really important, as they contributed to demolish the illusion that 'teacher - proof' projects could be produced and disseminated. But to put the teachers under a lens directed by the university researchers clashed against the tradition of a peer cooperation. Hence, if some results or analytical methods were to be borrowed from 'laboratory observation of processes' or whatever else, they should have been reconceptualised by means of a deep epistemological analysis of the way to gain knowledge concerning human activities. This was the reason why literature on participant observation, inherited from the anthropological tradition, entered the NRDs' libraries.

C) Design and analysis were not independent part of the work
In the design phase, a problem immediately came to the fore: For how long and how deeply was it necessary or timely to analyse classroom data? Surely, at the very beginning only a coarse grain planning of the experiment was done on the basis of previous epistemological and didactic analysis. Yet data from the classroom could upset this analysis and suggest a change of the strategy. When the experiment contained also teacher directed sessions (and this was usually the case in long term experiments) the quality of teachers' management could have been very different with different reactions from the classroom.

The designers had different choices:

to compress the experiment in a short period making sketchy analysis between sessions and emphasising the continuous and global feature of experience	to dilate the experiment over a long period making detailed analysis between sessions, and re-establishing the continuous and global feature of experience by a careful recourse to contract

In the first case, the detailed analysis, which was postponed, could have pointed at inappropriate choices; but in the second case, the effort in re-establishing the continuous and global feature could have resulted in something that is very time consuming (long teacher introductions; replication of problems in putting students into the situation; reading of previous documents, and so on) and, anyway, not always successful.

No best choice existed. Every choice had to be discussed by the research team (which included the teacher) and carefully examined on the basis of available information about the classroom. Some classrooms might already have been accustomed to having long intervals between two sessions on the same problems; others might not. In this case the teacher offered an invaluable expertise to settle the design.

The above were only three of the 'perturbations' introduced into the universe of didactic research, when the two internal traditions of 'concept based didactics' and of 'innovation in the classroom' came together and were confronted with external traditions. The challenge was to find a solution that could have made the most of the contributions coming from any of the traditions.

The discussion went on for years in the due places: the yearly meeting of NRDs for each school level (primary, middle and secondary) and, from 1986, in the National Seminar, held every year to discuss in depth some research projects, with the presence of official reactors from inside the field of didactics of mathematics or from neighbouring disciplines and, sometimes, from the traditions of other countries.

2. 3. The Birth of the New Paradigm

The early results of this reflective process were stated officially in 1992, in the 8th session of the National Seminar, where it was pointed out that most of the Italian studies in the didactics of mathematics addressed the phenomenon of teaching and learning mathematics and were based on the tradition of 'innovation in the classroom' with a deep mixing with the essential elements taken from 'concept-based didactics' and 'laboratory observation of processes'. The main aims of research were stated as follows:

(a) to produce paradigmatic examples of improvement in mathematics teaching and learning (in the form of projects for curricular innovations concerning either the whole mathematics curriculum or some special parts of it);

(b) to study the conditions for the realisation of such improvements as well as the possible factors underlying their effectiveness.

The term *research for innovation* has been introduced [1] to characterise this trend. From then on, several studies on 'research for innovation' have been produced, and the findings havebeen presented at international conferences and published in international journals or books. A strong experimental component (i. e. teaching experiments in the classroom) is characteristic of the studies, which, in this sense, are different from the ones produced earlier in 'concept based didactics'. A strong cognitive component (i. e. analysis of mental processes) is present as an influence of the participation in the PME group. The differences between'laboratory observation of processes' and 'research for innovation' have been discussed already. Hence what is left is to point out the main differences between 'innovation in the classroom' and 'research for innovation'. These could be summed up by answering the question: in what sense is 'research for innovation' different from the well known action-research, practised by a lot of teachers in their own classrooms?

Action-research is oriented towards practice and, often, ideologically a-theoretical. The emphasis is put on the 'art' of teaching and on the individual sensitivity of the teacher. The products are examples of good functioning in the classroom, to be used by other teachers as sources of ideas. Unfortunately, what happens very often is that a project that has worked quite well in one classroom, does not work in another one. In practice this failure is ascribed to the different background situations or the different personalities of the teachers.

In research for innovation, the design and the implementation of classroom experiments is linked to the development of models of the teaching-learning processes, which are basic results in themselves (hence used to advance the knowledge about classroom processes), yet might be used also to transfer experiments to new situations. In one sentence, action research produces didactic facts, while research for innovation produces and interprets didactic phenomena.

'Research for innovation' tries to overcome the distinction between theoretical and pragmatical relevance, by means of developing the relations between the two from the very beginning. This means the assumption of a diverse epistemological attitude towards the inquiring activity and implies the attribution of a new theoretical status to teachers. Actually, it is possible to distinguish three modes of relationships between observer and observed, the last being represented in our case by the whole of classroom processes, where teaching and learning cannot be separated from each other (this model is adapted from Raeithel, see [1] for details).

In what is usually called *action-research* (which shapes 'innovation in the classroom'), there is a na´ve problem solver (usually the teacher) who considers the meaning of the observed to be inherent, and who is not able to (or not interested in) building a symbolic structure inseparable from the perceived reality.

In what is known as the *classical science* approach (which not only inspired 'laboratory observation of processes' but also influenced by the French paradigm) there is a detached observer (usually different from the teacher) who aims at understanding the flow of activity by means of modelling the process in order to cope with its complexity.

In what we call 'research for innovation', there is a *participant observer* (the teacher--researcher), who develops a split between observer and observed in a dialogical relation. This is not an easy task, and it can be studied only over time, by analysing (self-analysing from the teacher's perspective) the development of the relationship between teaching and research activity during classroom work.

In the research studies that have been carried out until now, the legacies of the different traditions are evident. From 'concept based didactics', the interest in non-trivial pieces of mathematical knowledge and in their epistemological analysis is taken; from 'innovation in the classroom' the interest in the design and the implementation of teaching experiments is taken; from 'laboratory observation of processes' the interest in borrowing or inventing analytical tools for the study of classroom processes is taken. The influence of the French paradigm is visible in the tendency to produce a set of didactic theories, connected to each other, concerning different aspects of classroom process. A further elaboration of this point canbe found in [1].

2. 4. An Example. Theorems in School: from History and Epistemology to Cognition

To give a more specific idea of the type of 'research for innovation' outlined above, an example is presented. It is an ambitious project that involves four different teams (each including university researchers - namely F. Arzarello, M. Bartolini Bussi, P. Boero and M. A. Mariotti - with their co-workers and several teacher-researchers from all school levels) and which has already got a place in the international literature (the list of publications is in included in [3]). The project is still in progress and will lead to an articulated exposition expected for 1999-2000. By reconstructing some elements of the historical genesis of this project, it is possible to have an idea of the collaborative way of working developed not only within a team but also between different teams.

In the early nineties research teams at the universities of Genoa (P. Boero), Modena (M. Bartolini Bussi), Pisa (M. A. Mariotti) and Turin (F. Arzarello) started to work independently on the problem of proof. There was a shared need to counteract the documented international trend of cancelling theorems and proofs from mathematics curricula as a reaction to the formal approach. According to a legacy of the Italian tradition, attention was paid mainly (yet not exclusively) to geometry theorems. Some theoretical constructs developed earlier were assumed by all the teams, implicitly or explicitly, to help in the design, the implementation and the analysis of classroom experiments, whose aim was to create the conditions for most pupils to become able to produce proofs. The theoretical constructs concerned the setting of students' activity (see the construct of *field of experience* developed by Boero, [5]) and the quality of classroom interaction (see the construct of *mathematical discussion* developed by Bartolini Bussi [5]). Exploratory studies were produced at different school levels (from primary to secondary school). The presence of the teachers was decisive in each phase (design, implementation, collection of data and analysis). Their sensitivity and competence proved to be essential not only in the careful management of classroom activity but also in the elaboration of analytical tools and of the theoretical framework. Last but not least, while taking part in the design of experiments, the teachers were put in the condition of deepening some issues concerning the theoretical dimension of mathematics and its relationship with experiential reality. in other words, the theoretical dimension of mathematics became part of the intellectual life of teachers.

Generally speaking, most of the teaching experiments developed in the project shared (and continue to share) some common features, from the design phase to the implementation in the classroom:

1) the selection, on the basis of historico-epistemological analysis, of fields of experience, rich in concrete and semantically pregnant referents (e. g. perspective drawing; sunshadows; Cabri-constructions; gears; linkages and drawing instruments);

2) the design of tasks, within each field of experience, which require the students to take part in the whole process of production of conjectures, of construction of proofs and of generation of a theoretical organisation of the subject matter;

3) the use of a variety of forms of classroom organisation (e. g. individual problem solving, small group work, classroom discussion orchestrated by the teacher, lectures);

4) the explicit introduction of primary sources from the history of mathematics into the classroom at any school level.

The outcomes of the teaching experiments were astonishing when compared with the general insistence on the difficulty (or the impossibility) of coping with the theoretical dimension of mathematics. Most of students even in compulsory education (e. g.

grades 5-8) succeeded in producing conjectures and constructing proofs. Were these studies action research based, the process could have stopped here with the production and documentation of facts, i. e. paradigmatic examples of improvement in mathematics teaching. But the second aim of 'research for innovation' concerned the study of the conditions for realisation of such innovation, as well as the possible factors underlying effectiveness; in other words, this success had to be treated as a didactic phenomenon.

This created the need to framing, in an explicit way, the existing studies within a theoretical framework that allowed for the interpretation of them in a unitary way and for the suggestion of issues for a research agenda (see [5]). Two exemplary elements of the theoretical framework are described below.

On the basis of historico-epistemological analysis, a *mathematical theorem* is conceived as the system constituted by three interrelated elements: a statement (i.e. the conjecture produced through experiments and argumentations), a proof (i.e. the special case of argumentation that is accepted by the mathematical community) and a reference theory (including postulates and deduction rules - i.e. meta-theory). This conception emphasises the importance that students are confronted with the entirety of this complexity rather than with the mechanical repetition of given proofs. The *cognitive unity* is meant as the continuity between the processes of conjecture production and proof construction, recognisable in the close correspondence between the nature and the objects of the mental activities involved. This theoretical construct is, on the one side, a formidable tool for designing activities within the reach of students and, on the other side, a pointer of the difficulty, for analysing activities and for understanding some of the reasons for success and failure.

3. Some Open Problems

The different traditions in which 'research for innovation' is rooted represented different attitudes towards the problems of the impact on the educational system. Basic research usually does not address this issue, leaving the problem of wider applications to others. In the two internal traditions, in contrast, the issue was addressed, but only with an optimistic faith in teachers: in 'concept-based didactics', the teachers, provided with better pre- and in-service education were expected to be able to realise change; in 'innovation in the classroom', the teachers, provided with good opportunities for collaborative work, were expected to be able to passprofessional competence on to each other.

In 'research for innovation' both traditions coexist: the strong involvement of the members (both academic researchers and teacher-researchers) of the NRDs in the design of pre-service and in-service teacher education is rooted in the former tradition, whilst the involvement of new teachers is obtained by passing professional competence on to each other. However, with the increasing theorisation of the field, the attitude towards the teaching experiments has changed: from projects to be disseminated as such to research-type settings for the production of results to be disseminated.

The constitution of the NRDs was a social and cultural phenomenon that gradually expanded to the creation of a research network throughout the country. It must be said that this phenomenon was neither demanded nor initiated or controlled by the institutional agencies (like the universities, the schools or the Ministry of Education). This relative independence, on the one hand, gave, for years, an immense freedom to involve enthusiastic persons as volunteers, to generate new ideas and to cooperate intellectually with experts from outside the standard agencies, but created, on the other hand, the conditions for a scarce acknowledgedment (if any) of the image and the role of this new generation of academic researchers and teacher-researchers which had consequences for years.

Whilst the academic researchers are supposed to have found their own place within the community of mathematicians, the most problematic issue seems to concern teachers-researchers. They are now overbusy with their school activity (with no reduction of the schedule), with research activity, with teacher training activity. In the absence of institutional acknowledgement of what they do in the research field, their social status highly depends still on the individual attitude in playing a fundamental role within their own schools.

Some deep changes are in progress or expected soon in the Italian school system: a restructuration of cycles, and, as far as pre-service teacher education is concerned, an undergraduate university course for pre-primary and primary teachers and a post-graduate course for secondary teachers. In these courses an institutional role will be played also by expert teachers, who will be involved in practical lessons and training. The research activity of the NRDs has prepared not only a substantial corpus of research results on the teaching and learning of mathematics but also a lot of expert teachers. This creates, in a sense, a privileged situation for mathematics, because there no other research network in the country with the same diffusion and international acknowledgement for the other school subjects.

However optimism is untimely. The true impact on the education system of either the dissemination of research results or the activity of teacher-researchers will depend on additional variables that are neither under the control of academic researchers in didactics nor of teacher-researchers (and not even of mathematicians). Just to quote one of those involved: teaching is often (at least in Italy) conceived as a 'part time' job and not as a complex, important and demanding intellectual profession, where the teacher represents the role of science and knowledge with respect to human existence.

4. References

[1] Arzarello F. & Bartolini Bussi M., 'Italian Trends in Research in Mathematical education. A National Case Study from an International Perspective', in Sierpinska A. & Kilpatrick J. (eds.), *Mathematics Education as a Research Domain: A Search for Identity*, book 2 (241-262), Kluwer Academic Publishers: 1998.

[2] Barra M., Ferrari M., Furinghetti F., Malara N. A., Speranza F. (eds.), *The Italian Research in Mathematics Education : Common Roots and Present Trends*, Rome : Consiglio Nazionale delle Ricerche : 1992.

[3] Bartolini Bussi M., 'Drawing Instruments: Theories and Practices from History to

Didactics', *Documenta Mathematica* - Extra Volume ICM 1998 - III - 735-746.

[4] Malara N. A., Menghini M. & Reggiani M. (eds.), *Italian Research in Mathematics Education 1988 - 1995*, Rome: Consiglio Nazionale delle Ricerche: 1996.

[5] Mariotti M. A., Bartolini Bussi M., Boero P., Ferri F. & Garuti R. (1997), 'Approaching Geometry Theorems in Contexts: From History and Epistemology to Cognition', in *Proc. XXI PME International Conference*, vol. 1, 180-195, Lahti (Finland).

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Sir James Lighthill, 1924-1998

Geoffrey Howson

The death occured in July of James Lighthill who was President of ICMI from 1971 to 1975. Lighthill was one of the leading applied mathematicians of the century and a phenomenally gifted person. After taking a two-year B.A. at Cambridge during World War II, Lighthill went to work at a government scientific laboratory. Shortly after the war ended he moved to Manchester University where, in his early twenties and without a research degree, he was immediately appointed as a Senior Lecturer. In 1950, at the age of 26, he became Professor! In his 30s he left university work to be Director of the Royal Aircraft Establishment, Farnborough and after a succesful period there returned to academic life in the 1960s. He later held Newton's old chair at Cambridge before becoming Provost (Rector) of University College, London.

Lighthill's contributions to mathematics education were mainly made in the 1960s and 1970s. He was on several important committees in England and in addition to being President of ICMI at the time of the second International Congress on Mathematics Education (Exeter, England, 1972) he was also Chairman of its Organising Committee. Several seminars were supported by ICMI during his term of office, the most important probably being that, held jointly with UNESCO, at Nairobi, Kenya (1974) on "Mathematics and Language". Lighthill also gave the opening plenary talk at ICME 3 (Karlsruhe, Germany).

Lighthill was, amongst his other attainments, a great linguist - one interest of his was Portuguese literature. Two of his favorite hobbies, however, were music, he was a keen pianist, and swimming. During his life he made many long distance swims and it was on one of these, round the Island of Sark (in the Channel Islands) that he suffered a fatal heart attack.

Geoffrey Howson

Efraim Fischbein, 1920-1998

Dina Tirosh and Tommy Dreyfus

Efraim Fischbein died on Wednesday, 22 July 1998. His death is a great loss to his family, to his students and colleagues at Tel Aviv University and to the entire community of mathematics educators.

Fischbein was born in Romania, in 1920. He taught mathematics and philosophy in high school. In 1949 he was offered the position of lecturer at the department of Department of Educational Psychology at the University of Bucharest, and from 1959 to 1975 he served as the head of the Educational Psychology department at the Institute of Psychology in Bucharest. His work on child development, cognitive psychology, and mathematics education during that period is characterized by the originality of the questions he asked, his systematic methods of exploration and the insights he provided in the interpretation of the data. His many books and articles created international interest, and he was frequently invited, from behind the Iron Curtain, to conferences and meetings in western countries.

By 1975, Efraim Fischbein was internationally known as one of the leading researchers in mathematics education. After leaving Romania for Israel, he was offered an appointment as professor of mathematics education at Tel Aviv University where he founded the Department of Science Education and continued to teach, to be active and creative in research, and to supervise many research students until his last moments.

Efraim Fischbein is best known for his creative, systematic, coherent and influential contribution to the knowledge about, and the understanding of the role of intuition in learning and teaching mathematics and science. His first contributions in this area concerned intuitions of probability and combinatorics; they established a strong bridge between psychology and education and were published internationally in journals from both domains, including Educational Studies in Mathematics and The British Journal of Educational Psychology. In the preface to Fischbein's book "The intuitive sources of probabilistic thinking in children" (Reidel, 1975), Hans Freudenthal related in warm words to the contribution of Fischbein's approach and wrote: "I interpret and welcome Fischbein's work as a major breakthrough in mentality of research in the field of developmental psychology. ... I consider Fischbein's shifting the stress from concepts to intuitions as a cognitive advance which may benefit teaching mathematics."

Fischbein's desire to understand the nature of intuitive thinking and the relationship between intuitive and other forms of thinking is evidenced in his further work on infinity, on implicit models of multiplication and division, on irrational numbers, on the relationship between intuitions and proofs, on the interaction between the formal, the algorithmic and the intuitive components in mathematical activities, and other topics. In "Intuition in Science and Mathematics" (Reidel, 1987) Fischbein proposed a theoretical, comprehensive view of the domain of intuition, identified and organized the related experimental findings, and described and discussed their educational and didactic implications. In this book, like in other publications, he coined new, useful terminology (e.g., primary intuitions, secondary intuitions), raised problematic issues (e.g., the educational dilemma) and stimulated further related research, thus leading the field of mathematics education ahead. It is not surprising that his articles were published in four languages and translated into many others.

Another major contribution of Efraim Fischbein to the domain of mathematics education relates to the creation and the organization of PME, The International Group for the Psychology of Mathematics Education. He was the organizer, the first president and an honorary member of PME. He actively participated in almost all the annual meetings of PME, and contributed a great deal to the ongoing development of the organization. His imprint on this important constituent of our field will be felt for many years to come.

At the beginning of 1998, Efraim Fischbein started working on a third book entitled "Intuitions, Schemata and Models in Mathematical and Scientific Reasoning". Unfortunately, he was unable to finish this work. But his books, his articles, and mainly his ideas will stay with us forever, and his contribution to mathematics education will serve as a permanent memorial to him, and as a never-ending source of inspiration for us all.

Dina Tirosh and **Tommy Dreyfus**

New PME Officers

At the last meeting of the International Group for the Psychology of Mathematics Education (PME) the following officers were chose for the International Committee of PME:

President: Gilah Leder, Austrlia (g.leder@latrobe.edu.au)
Vice President: Judith Mousley, Australia (judym@deakin.edu.au)
Secretary: João Filipe Matos, Portugal (joao.matos@fc.ul.pt)
Treasurer: Gard Brekke, Norway (gard.brekke@hit.no)

Executive Secretary: Joop van Dormolen, Rehov Harofeh 48A, Haifa 34367, Israel, (joop@tx.technion.ac.il).

The next PME conference will be held in Haifa, Israel, 25-30 July 1999 (see Future Conferences).

Access to Literature in Mathematics Education - an Introduction to MATHDI

Gerhard König

1. Introduction

There has been a substantial increase in publications dealing with research in mathematical education in general and on experiments in various countries, new pedagogical concepts and insights, topics, and teaching concepts in particular. One of the features of this growth is the increasing number of conference proceedings, collections of papers, reports, etc. being published. Another aspect is the expansion of journals in this field in both number and page count. Journals are of great importance for everyone interested in national developments as well as for an international exchange of ideas. About 400 journals on mathematics education and /or computer science education serve worldwide as channels for scientific communication (for an overview, see http://www.zblmath.fiz-karlsruhe.de/zdm/zdmzs.html). Educational professionals like other scientists are thus faced with the problem of how to extract from a vast pool of potential information those items which they need for their own work.

The purpose of this paper is to provide an insight into how to cope with this flood of information. The reader is given some information of the international services, located in Germany, which may help him keep up to date with the current progress in elementary mathematics and mathematical education: abstracting journals and online databases; especially we will focus on Zentralblatt für Didaktik der Mathematik, produced by the German non-profit organization Fachinformationszentrum Karlsruhe (FIZ Karlsruhe), and start by considering this unique journal for maths educators.

2. Printed abstracting service in mathematics education: ZDM

Zentralblatt für Didaktik der Mathematik (ZDM), English subtitle: International Reviews on Mathematical Education, is an information and abstracts journal in the field of mathematical and computer education, from elementary level to teacher training and adult education. This well-established journal started in 1968 within the field of mathematical education and expanded its scope twenty years ago to computer science education. The journal appears every two months, each issue containing a documentation section and an articles section with state of the art articles or articles of particular current interest to educational professionals.

The main part of ZDM is dedicated to documentation. The documentation section is an abstracts service and reference tool providing ready access to worldwide publications on topics of interest to mathematics educators and mathematics teachers. The information presented is extracted from all relevant documents. This includes journal articles (of more than 400 journals worldwide in about 10 languages), textbooks, teaching aids, reports, dissertations, conference papers, and curricula. The publications are announced in the documentation section by bibliographic data and abstracts mostly in English and sometimes in French or German.

Subject coverage :

- Research in mathematical education,
- methodology of didactics of mathematics,
- mathematical instruction from primary school to university teaching and teacher training,
- elementary mathematics and its applications,
- computer science education,
- basic pedagogical and psychological issues for mathematics and science education.

This abstracting service enables specialists in mathematics education to keep up with the literature in their subject by providing them with a manageable source of information on current developments, controversies and advances, selected from virtually the whole of the international literature. In addition ZDM assists in maximizing the use of the time scholars have available for reading. They spend their available reading time scanning core journals and can then use abstracting services covering their field to identify other papers, published in less familiar journals or in journals published abroad, which will be of relevance to their research.

3. Online Database MATHDI in mathematical education

MATHDI (MATHematical DIdactics) is the ZDM electronic database. It is produced, designed and offered by FIZ Karlsruhe and is available worldwide via STN International. It provides the quickest and most convenient access to literature in mathematics education and computer science education. It contains all literature reviewed in ZDM since 1976 totaling 78.000 references (30.09.1998). Some 4.500 items are added each year.

If one needs an overview on relevant scholarly publications for writing an article, delivering a conference speech or approaching a new working field a search in MATHDI will help to be up to date. Especially with the computer on-line search the searcher has almost unlimited flexibility to tailor the results to precise specifications, to be as broad or as narrow as desired, to include or exclude certain factors, or to combine concepts.

MATHDI online is easily and quickly accessible from all over the world via all telecommunication networks (e.g. DATEX-P, WIN/IXI, DATAPAC; Radio Austria, TELNET; TYMNET etc.), as well as via Internet. MATHDI database on STN International is available in:

Europe/World via FIZ Karlsruhe (E-mail: GK@fiz-karlsuhe.de)

in North America via Chemical Abstracts Service in Columbus/Ohio (E-mail: help@cas.org)

MATHDI Database

Mathematical Didactics 1976 - present

Start Retrieval		**MATHDI Help**		Clear Form
Author				
	[Lastname *or* Lastname, Initial *Example:* Kilpatrick *or* Kilpatrick, J] [*Several authors:* Name1, Initial1; Name2, Initial2 *Example:* Wiles; Taylor, R]			
Title contains				
Global index contains				
Source contains				
Classification				
		Classification: **Combined navigation and search**		
Publication year:	to			
Display:	10 entries per page			
Start Retrieval		**MATHDI Help**		Clear Form

On the Internet MATHDI is offered through the World Wide Web via the EMIS service of the European Mathematical Society (EMS). There is free access to the sneak preview of MATHDI if you are content with only three items of information for any query. All a user needs to do is to open the

URL: http://www.emis.de/MATH/DI.html.

ZDM subscribers can have full service for a small additional annual fee (DM 350.- in 1999).

Example: Find publications on TIMSS. Result: there are 48 publications on TIMSS in MATHDI. In the following the first two records.

L1 ANSWER 1 OF 48 MATHDI COPYRIGHT 1998 FIZ KARLSRUHE

AN 98(4):MD3205 MATHDI

TI Mathematics and science achievement in the final year of secondary school. IAE's third international mathematics and science study (***TIMSSS***).

CS Center for The study of Testing, Evaluation and Educational Policy (CSTEEP), Chestnut Hill, MA (United States). Third international Mathematics and Science Study (TIMSS) Center

SO Feb 1998. 351 p. Available from TIMSS International Study Center, Boston College, Chestnut Hill, MA 02167 (USA).

DT Miscellaneous

CY United States

LA English

AB This report of the TIMSS study presents mathematics and science literacy achievement results for 21 countries. The main purpose of TIMSS was to focus on educational policies, practices and outcomes in order to enhance mathematics and science learning within and across systems of education. The present report focusses on the literacy of all students in their final year of upper secondary school, and on the advanced mathematics and physics achievement of final-year students who have taken advanced courses in those subjects. There are two types of tests described: The mathematics and science literacy test was designed to measure the learning of all final year students who are at the point of leaving school and entering the workforce or postsecondary education. The advanced mathematics test was designed to measure learning of advanced mathematics concepts among final-year students who have studied advanced mathematics.

CC *D14 COMPREHENSIVE WORKS ON MATHEMATICS EDUCATION (11TH TO 13TH YEAR OF SCHOOL, UPPER SECONDARY)
D10 COMPREHENSIVE WORKS ON MATHEMATICS EDUCATION

ST COMPARATIVE STUDIES; MATHEMATICS LITERACY; ACHIEVEMENT; ACHIEVEMENT MEASUREMENT; CURRICULUM; GENERAL EDUCATION; UPPER SECONDARY; VOCATIONAL EDUCATION

```
L1   ANSWER  2 OF  48  MATHDI  COPYRIGHT  1998 FIZ KARLS-
     RUHE
AN   98 (4): MD3204  MATHDI
T1    ***TIMSS***   released item set for the final year
     of secondary school: mathematics and science litera-
     cy, advanced mathematics, physics. IEA's third inter-
     national mathematics and science study.
CS   Center for the Study of Testing, Evaluation and
     Educational Policy (CSTEEP), Chestnut Hill, MA (Uni-
     ted States), Third International Mathematics and
     Science Study (TIMSS) Center
SO   $[1998]$. 195 P. Available from TIMSS International
     Study Center, Boston College, Chestnut Hill, MA 02167
     (USA).
DT   Miscellaneous
CY   United States
LA   English
AB   TIMSS is a collaborative research project. In 1994-95
     achievement test of mathematics and science were
     administered to samples of students in classrooms
     around the world. This book deals with students in
     their final year of secondary education, including
     students taking advanced courses. The items are
     presented, the solutions are discussed and commen-
     taries are given. There are many statistical tables
     interpretating the data.
CC   *D14 COMPREHENSIVE WORKS ON MATHEMATICS EDUCATION
     (11TH TO 13TH YEAR OF SCHOOL, UPPER SECONDARY)
ST   COMPARATIVE STUDIES, ACHIEVEMENT; MATHEMATICAL LI-
     TERACY; UPPER SECONDARY; VOCATIONAL EDUCATION; ACHIE-
     VEMENT MEASUREMENT
```

4. CD-ROM MATHDI

MATHDI is also available through a CD-ROM which offers the following attractive features:

1. reviews and bibliographic data from ZDM, from 1976 to 1997 (73,000 data in mathematical education),
2. time-independent searching, freeing the user from the uncertainties of the Web
3. no additional costs e.g. telecommunications costs.

CD-ROM allows to search with a command language (retrieval language used on the STN International host) or with an independent menu system.

Now, for the first time, one can have instant access, every hour of the day, to literature about mathematics education throughout the world. The CD-ROM MATHDI is the most appropriate medium of output, when you need information on your desk, your working place or directly on your computer. It is also convenient in libraries for students use.

5. Concluding remarks

You have learned in this article how to get information on published articles or books, either to locate studies or to get inspired by a classroom experiment, or to be better informed about the accomplishments of one of your colleagues. To access the information in our field of didactics of mathematics you use ZDM or its bibliographical database MATHDI.

For more information on the products described here please contact:

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Fachinformationszentrum Karlsruhe
D 76344 Eggenstein-Leopoldshafen
e-mail: gk@fiz-karlsruhe.de

FUTURE CONFERENCES

SEACME-8, May-June 1999

The 8th Southeast Asian Conference on Mathematics Education, SEACME-8, will be held 30 May - 4 June 1999, at Ateneo de Manila University, Manila, the Philippines, under the auspices of the Southeast Asian Mathematical Society. The theme of the conference is 'Mathematics for the 21st Century'.

For further information, please consult

http://165.220.5.49/seacme8/seacme.html

or the organising body

SEACME-8
Mathematics Department
Ateneo de Manila University
Katipunan Road, Loyola Heights
Quezon City 1108
P.O.Box 154 Manila 0917
The PHILIPPINES
tel: + 632 426-6125
fax: +632 426-6088
e-mail: seacme8@mathsci.math.admu.edu.ph

ISAMA 99, June 1999

The First Interdisciplinary Conference of the International Society for the Arts, Mathematics, and Architecture, ISAMA 99, will be held in San Sebastian, Spain, 7-11 June 1999.

The main purpose of ISAMA 99 is to bring together persons interested in relating mathematics with the arts and architecture. This includes teachers, architects, artists, mathematicians, scientists and engineers. As in previous conferences, the objective is to share information and discuss common interests. The conference will focus on the following fields related to mathematics: Architecture, computer design and fabrication in the arts and architecture, geometric art and origami, music, scuplture and tessellations and tilings. These fields include graphics interaction, CAD systems, algorithms, fractals and graphics within mathematical software (Maple, Derive, Mathematica, etc.). There will also be associated teacher workshops.

Abstracts of papers should be submitted to the conference secretariat by 15 December 1998.

For further information, please consult

http://www.sc.ehu.es/isama99

or the Conference Secretariat

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e-mail: artmath@math.albany.edu

Creativity and Mathematics Education, July 1999

An international conference to consider questions such as 'How to promote creativity of our children?', 'How to stimulate our teachers?', 'How to enrich mathematics education with creative activities?', will be held 15-19 July 1999 in Münster, Germany.

The deadline for the submission of papers is 28 February 1999.

For further information, please consult

http://wwwmath.uni-muenster.de/math/inst/didaktik/
u/meissne/www/complete1.htm

or contact the conference chair

Professor, Dr. Hartwig Meissner,
Fb. Mathematik
Universität Münster,
Einsteinstrasse 62,
D-48149 Münster
GERMANY
fax: +49 251 83 32718
e-mail: meissne@uni-muenster.de

CIEAEM 51, July 1999

The 51st conference of the International Commission for the Study and Improvement of Mathematics Education (Commission internationale por l'étude et l'amélioration de l'enseignement des mathématiques), CIEAEM, will take place in Chichester, Sussex, England, 21-26 July 1999. The general theme of the conference is 'Productive

Collaboration in Mathematics (Education) across Cultures', with sub-themes 'Looking back, moving forward' (includes evolution and contribution of non-European cultures), 'Effective co-operation between mathematics (educators) and users of mathematics', 'Coping with diversity of student/pupil interests, abilities, aptitudes, and background', 'Mathematics cultures across different sectors of education', 'Beliefs and practices in the teaching and learning of mathematics'. The scientific activities include plenary sessions, working groups, individual or group presentations, workshops, forum of ideas, and special sessions. The official conference languages are French and English. For further information, please contact

CIEAEM 51
The Mathematics Centre
Chichester Institute of Higher Education
Uppor Bognor Road
Bognor Regis
PO21 1 HR
ENGLAND
tel: +44 1243 816378
fax: +44 1243 816362
e-mail: maths@chihe.ac.uk

PME-23, July 1999

The Psychology of Mathematics Education (PME) conference of 1999 will be held in Haifa, Israel, 25-30 July 1999. The Conference Chair is Orit Zaslavski. The First Announcement was sent to PME members in September 1998.. All others who are interested can obtain a copy through the Internet home page of the conference

http:// edu.technion.ac.il/conference/pme23

or from the Executive Secretary of PME

Dr, Joop van Dormolen
Rehov Harofeh 48 Aleph,
34367 Haifa
ISRAEL

ICTMA 9, July-August 1999

The 9th International Conference on the Teaching of Mathematical Modelling and Applications, ICTMA 9, will be held in Lisbon, Portugal, 30 July - 3 August 1999. The aim of this conference is to provide a forum for the presenttion and exchange of information, experiences, opinions and ideas relating to the teaching, learning and assessment of mathematcal modelling, mathematical models and applications of mathematics. People engaged in research or practice in these topics at secondary and higher levels of education are invited to participate, present papers or conduct workshops. There will also be provision for those who would like to make a poster presentation of work in progress or of smaller scope than would warrant a full paper or workshop.

For further information, please consult

http://www.fc.ul.pt/educacao/ictma9

or the Chair of the Programme Committee,

Professor João Filipe Matos
Departamento de Educação, Faculdade de Ciências
Universidade de Lisboa
Campo Grande C1
1700 Lisboa
PORTUGAL
fax: +351 1 7500082
e-mail: joao.matos@fc.ul.pt or ictma9@fc.ul.pt

SEMT 99 - International Synposium on Elementary Mathematics Teaching, August 1999

The International Synposium on Elementary Mathematics Teaching - SEMT 99 - will be held at the Faculty of Education of the Charles University, Prague, the Czech Republic, 22-27 Agust 1999. The programme will be focused on the teaching of mathematics to children within the age range 6-11 years. More specifically, the theme of the present conference is "How the world of mathematics emerges from everday experiences of children".

The syposium will consists of plenary sessions, workshops, presentation of papers, working groups, discussion groups and poster presentations. Workshops will be organised across three sessions.

Abstracts of submitted papers should be with the Programme Committee no later than 1 February 1999.

For further information, please consult

http://www.pedf.cuni.cz/k_mdm

or contact the Organising Committee, at

SEMT 99
Department of Mathematics and Mathematical Education
Faculty of Education
Charles University
M.D.Rettigové 4
116 39 Praha 1
The CZECH REPUBLIC
e-mail: jarmila.novotna@pedf.cuni.cz

Third European Congress of Mathematics, July 2000

The Third European Congress of Mathematics will be held in Barcelona, Spain, 10-14 July, 2000. Further information will be released in due course.

ICME-9, July-August 2000

The Ninth International Congress on Mathematical Education, ICME-9, is going to be held 31 July - 7 August 2000, at the Chiba Convention Centre, Makuhari, at the Tokyo Bay, near Narita Airport. Further information will be available in forthcoming issues of this Bulletin.

ICMI and the ICMI Bulletin on the World Wide Web and on E-mail:

Information about ICMI, including the most recent issue of the ICMI Bulletin, is now available from the ICMI pages of the IMU server at the Konrad-Zuse-Zentrum für Informationstechnik Berlin, (Germany). These pages can be found through URL:

http://elib.zib.de/imu/icmi

Direct access to the ICMI Bulletin on the WWW, through the IMU-server, is obtained by the URL:

http://elib.zib.de/imu.icmi.bull.[no] or http://elib.zib.de/imu/icmi/bulletin/no

The ICMI Bulletin is also stored as an ASCII file in the editor's (i.e. the ICMI Secretary's) electronic mail system. If you want to receive a copy of this issue as an ASCII text through e-mail, please contact Mogens Niss at <mn@mmf.ruc.dk>.

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