DG 3: Mathematics education for whom and why? The balance between "mathematics education for all" and "for high level mathematical activity"

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Aims and focus

Worldwide, educational ministries, institutions and societies are trying to answer this hot and controversial headline theme in different ways. Discussion Group 3 recognised both the diversity of social, economic, political and cultural problems in the different countries and at the same time some similarities in hopes and aims for mathematics education. The debate was centred on five questions:

Question 1: *Who should receive what kinds of mathematics education, why, and with what goals?*

Question 2: *Is the dichotomy between 'mathematics for all' and 'for future mathematicians' genuine?*

Question 3: *How can 'mathematics education for all' embrace opportunities for 'high-level mathematical activity'? But also: How can 'mathematics for high level activity' embrace opportunities for 'mathematics education for all'?*

Question 4: *How can instructional practices support the development of highly motivated mathematics learners as well as mathematics for all?*

Question 5: *What is mathematical literacy? Must mathematical literacy be the same for all? If not, does mathematical literacy depend on socio-cultural factors? Why?*

Organisation

Discussion Group 3 organized its work this way: In the first part of Session 1, L. Lindenskov made a presentation in Power Point of: i) the purposes of the discussion group; ii) the answers given by panellists R. Askey, S. Carreira, Y. Namikawa and R.Vital, who in a plenary session at ICME-10 had expounded their points of view on the headline theme; iii) the questions asked by the Organizing Team and divulged through the ICME web page; and iv) the contents of the documents presented as materials in the same web page related to the questions asked by the Organizing Team and by G. Malaty, V. Freiman and B. Evans. In the second part of Session 1, the participants made groups freely, in order to exchange points of view with respect to the ideas expounded by the panellists.

In Session 2, S. Garfunkel synthesized what the DG 3 had advanced in the previous session, and the Team Chairs asked participants to divide into four groups to continue with the discussion and to answer the questions. Each subgroup handed in the result of their work at the end of the session. Having these products as a basis, M. Villavicencio and L. Lindenskov systematized the answers and elaborated on them in a work document.

In Session 3, this document was handed in. This document was presented by M. Villavicencio in Power Point and served as a basis for the discussion in the plenary group meeting. Owing to the lack of time to agree with all that was presented, the Organizing Team considered it appropriate to continue the discussions electronically among the participants after the congress through e-mails.

Discussions and recommendations

Following up, the main themes in the discussions – as seen by the organizers and contributors – with respect to the five questions and answers and recommendations for the formulation of policies were displayed. Elaborated results from the e-mail discussions will be displayed on the website.

Question 1: *Who should receive what kinds of mathematics education, why, and with what goals?*

Everybody should receive mathematics education, because they need thinking tools for work, everyday life and citizenship that can be developed by learning mathematics, and because mathematics gives them possibilities for enjoyment, creativity and for personal development. Mathematics makes use of a universal language to describe nature, human society, and so on, and it helps to train logical and abstract thinking; and given that it uses models, mathematics helps in learning systematically to understand things or to solve problems.

In order to ensure mathematics for all, unequal opportunities in mathematics education have to be overcome. That means that it is crucial to give more attention to and guarantee appropriate math education for:

- Female children – Such actions are necessary, for instance, because male-centred traditional customs usually guide girls, even though mathematically talented, to choose the college departments unrelated with mathematical fields. Parents and even teachers do not expect girls to learn mathematics as well as boys
- People in the rural areas – Particularly for native people who speak their mother tongue and have traditional cultural background, and for minority socio-cultural groups (e.g. immigrants). Generally, rural areas, compared with urban areas, have an educationally inferior environment in aspects of teaching, mathematical competency, parents' educational expectations and information, and so on.
- Those who have special needs – i.e. who are blind or handicapped should be given special attention.
- Children and adults, illiterates and other vulnerable groups in society.

The DG 3 recommended that an educational system should emphasize:

- Cultivating mathematical ability and curiosity, and not isolated skills and knowledge.
- Providing students with experiences that put emphasis on the mathematical problem solving and thinking abilities (reasoning and communication).

- Providing students with experiences that give a broad perspective to the mathematics content and structure and to the relations among the various topics, starting at a young age.
- Supporting teachers to overcome their own bad learning experiences.

Mathematics education – like other subjects – must support universal social values (solidarity, tolerance, openness, inclusiveness and attitudes to maintain a dialogue in our own social group and with others) seeking for the well-being of mankind.

***Question 2**: Is the dichotomy between 'mathematics for all' and 'for future mathematicians' genuine?*

It seems to the organizers that, with question 2 and 3, the participants faced the biggest challenges in their efforts to interpret and understand each other's viewpoints. Some participants defended the viewpoint that a solid mathematical ground is a necessary prerequisite for engaging with any use of mathematics; others defended that learners can develop both areas simultaneously. The majority of the participants tended to give the following answer to question 2:

No, the dichotomy is not genuine. It is not genuine because high-level learners also need mathematical literacy. While everybody needs mathematical literacy, it is not needed that all people acquire high-level mathematics. But the scientific, technological and welfare development of the world needs a great many responsible mathematicians, who must be capable also in mathematical literacy.

Especially for adults, mathematics education must answer to their needs, expectations and intentions.

Question 3: *How can 'mathematics education for all' embrace opportunities for 'high-level mathematical activity'? How can 'mathematics for high level activity' embrace opportunities for 'mathematics education for all'?*

It might be a common belief that 'math education for all' should and could ensure the development of capabilities and high levels of performance for some learners. We share this belief, and in this sense, 'math education for all' can embrace opportunities for 'high-level mathematical activity' by teaching with challenging situations accommodations to different kinds of students.

The opposite direction is not so commonly demonstrated. In our view, however, 'mathematics for high-level activity' also ought to embrace opportunities for 'mathematics education for all' to ensure that high-achieving learners learn more than abstract de-contextualised math knowledge, also they should be given opportunities to acquire mathematical literacy by problem-posing and solving in authentic contexts.

This reflects on what mathematics education must be given, and which interesting ideas must be displayed? Which tools must be used? Which questions must be asked? How do we support an appropriate teacher's mathematics knowledge and their ability to create a meaningful learning environment in which each student would be given opportunity to realize her full potential? Also, particularly in the developing countries, what information and training must be provided for the teachers of different basic education levels?

Question 4: *How can instructional practices support the development of highly motivated mathematics learners as well as mathematics for all?*

Instructional practices can be supportive to all groups of learners by:

- Considering different learning styles and using a variety of instructional strategies and materials. Developing and nurturing mathematical critical and creative thinking is not possible solely with routine activities (say, arithmetical tasks and applying algorithms told how to be used by the teacher).
- Emphasizing a participatory role for learning. That means using mathematical language, oral discussion, and writing, listening and observing skills; creating mutual respect and equal treatment regardless of ability; expanding career and economic horizons; incorporating technology as a thinking and learning tool; and assessing performance through a variety of evaluation techniques.
- Valuing the learners' creativity and supporting discussions and reflections on different strategies and the use of different means.

Question 5: *What is mathematical literacy? Must mathematical literacy be the same for all? If not, does mathematical literacy depend on socio-cultural factors? Why?*

Mathematical literacy could be defined as "An individual's capacity to identify and understand the role that mathematics [practice and knowledge] plays [and could play] in the world, to make well-founded mathematical judgements and to engage in mathematics, in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen" (Mathematical Literacy defined in PISA (Programme for International Student Assessment), www.pisa.oecd.org/pisa/math.htm, July 2004.)

This definition is valid for the human being as a citizen of the world, a world in an accelerated process of globalisation; and in this global village, mathematical literacy must be the same for all.

In actual practice, we are very far from this mathematical literacy as something which is the same for all. As the first step it might be appropriate for members of the mathematics education community to refer to a more local mathematical literacy that can be national or regional, according to the environment for which the person's mathematical capabilities are functional, that is, that permits him/her to respond to the needs of his/her current and future life as a constructive, responsible and reflective citizen in his/her country or region. Such necessities evidently vary from one community to another, and from one epoch to another, because, for example, the socio-economic and cultural reality of a European city requires that a person acts with knowledge and mathematical capabilities very different to those that an inhabitant of the Peruvian mountains needs to unfold with efficiency, efficacy and effectiveness in his own socio-cultural context; and the requirements of today's corresponding populations are different to those of fifty years ago. From this point of view mathematical literacy is relative; it depends on the demands of the persons' social, economic, and cultural reality in a given environment and time.

From the viewpoint of mathematics education being a means to enhance intercultural understanding, however, mathematical literacy in a broader sense could be realized by providing students from, say, European cities with knowledge of the mathematical culture of, say, Peruvian peers living in rural areas, and vice versa.

Conclusion

DG 3 seems to have succeeded in:

- giving room for an open and engaging exchange of different views
- formulating some answers and some recommendations.

Time did not allow the DG to focus on questions such as: Is there sometimes a tendency to say 'what not everyone can learn, nobody should learn'? Does every student need to take mathematics courses every year? What is the future of mathematics as an education subject in a changing world dominated by technology? Is more better, or …?

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