

Mathematics Education Between Theory And Practice; Narrowing The Gap: A Necessary Condition For Reform

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This paper is an attempt to deal with some aspects of reform in mathematics education from the scope of achieving a relative consistency between theory and practice in the area, a matter which is characterized by complexity.

The paper includes; basic assumptions on which the whole attempt is built, examples of the gaps between theory and practice in mathematics education and attempts to fill them, then a discussion of further considerations for reform.

The paper reached a conclusion that “functional integration” of the study of mathematics with other disciplines and practical life might be the point of departure for reforming mathematics education. It discussed some relevant considerations, calling for a “new mathematics education through new curricula”, a matter whose achievement depends on collective creative work from different groups, but which eventually depends on the local educational system and its interactions with other supra systems, including the national, regional and human cultures.

Introduction and Basic Assumptions

The major aim of the present paper is to contribute to the establishment of a new approach to reform in the area of mathematics education. Such an approach depends on attempting to achieve a relative consistency between theory and practice in the area, a matter which is characterized by complexity.

The following assumptions, on which the paper is based, could reveal some aspects of the nature of the issue:

- 1- There is neither a comprehensive theory for mathematics education nor a consistent set of practices in the area. Nevertheless, there are contradictory paradigms of mathematics, particularly “seeing mathematics as the study of formal systems” vs the emerging paradigm of “ seeing mathematics as a living body” (9 and 11: 611), a matter which has strong implications for teaching the subject. On the other hand, there is a wide range of almost inconsistent practices in this concern, especially in the areas of methods of teaching, school activities, systems of evaluation and, to some extent, contents.
- 2- Although it is natural to find a gap between theory and practice, which takes different forms and directions, there must be a continuous process of attempting to narrow such a gap.
- 3- Narrowing the gap between theory and practice in mathematics education is a mere, but insufficient, necessary condition for reform, that is, the system of mathematics education is a sub system of many supra systems. Therefore, reforming it is a complex process which goes far beyond the technicalities in the area.
- 4- As a result of the previous assumptions; although there might be common problems in the area, alternative solutions vary according to cultural considerations, as well as within the same society according to different conditions.
- 5- Although intelligence can be seen as the ability, to solve a problem, to create a problem to solve and to contribute to one’s culture, there are at least seven forms of intelligence ⁽¹⁾ of equal importance (See; 14). Every person possesses – to varying degrees- all seven ways of knowing while the dominant intelligence may support the weaker ones. Further, each of the intelligences can be developed depending on how an individual is nurtured. Individuals are capable of developing their intelligences well beyond what ability they were born with and regardless of cultural or environmental circumstances (14:2).

6- School mathematics should deal with basic requirements to learn mathematics which is actually practised by mathematicians, particularly with regards to its applications in other disciplines and in life at large, in the context of such applications.

7- Interests of students towards the study of mathematics is a controlling factor in the future of the growth of the subject.

Based on the above mentioned assumptions, the present paper appraises examples of the gaps between theory and practice in mathematics education and attempts to fill them, and proceeds to discuss further considerations for reform.

Examples of the Gaps between Theory and Practice in Mathematics Education and Attempts to Fill them

Although such gaps are a cause of complaint everywhere, they are in general more applicable in developing countries. Furthermore, educators consider these gaps as single ones or – at best – as combinations of some, not in a comprehensive way, a matter which results in partial views, a matter which we are attempting to avoid.

The most important gaps between theory and practice in mathematics education seem to be as follows (2):

1- Integration between mathematics and its applications, both in different disciplines and in actual life, while introducing mathematics as a separate subject and, almost, in “formal” form, with little, or none, of “mathematical modelling”.

2- Employing some different methods of teaching, different means of reasoning as well as different classroom activities in the framework of “multiple educational media systems”, while restricting instruction mostly to the lecture and partly to discussion methods, verbal learning and/or formal deductive reasoning.

3- Rejecting rote learning and memorization, while students are asked to memorize a wide range of materials, from the “multiplication table” to theorems and some problems.

4- Coping with scientific developments, while sticking almost to the “linear model”, which has nothing to do with either modern sciences or practical life (See; 8).

5- Developing the ability of problem solving and creativity through many different means, including dealing with open answer questions, “research problems”, employing the “historical cultural approach” (See; 6)... etc, while concentrating on “typical” problems both in teaching and examinations.

6- Self-learning, while there are neither suitable enrichment materials nor simplified mathematics dictionaries available. In connection with this point, at least two issues can be raised; the extent, if any, of using computers in learning and self-learning in particular, and the availability of different materials to meet individual differences among students.

7- Developing students interests towards studying mathematics, while supporting the bad “halo-effect” of the subject and dealing with relevant “school activities” -if any- in an almost meaningless way for the majority of students.

Needless to say, the above mentioned gaps are interrelated and interacting among themselves and with other educational and cultural aspects.

The careful revision and analysis of these gaps could lead us to conclude that the point of departure for filling them is to apply the paradigm shift in mathematics, as referred to above, into the area of mathematics education. This shift can be reflected in primary school mathematics programmes “from seeing mathematics as a large collection of concepts and skills to be mastered in some strict partial order to seeing mathematics as something people do” (12:3655) and in secondary school mathematics programmes from the “formal” teaching of mathematics to introducing mathematics as a human activity in order to provide a basic preparation of learners for the full participation as functional members of society (15: 3661). This implies that the key point to fill the gaps referred to above, i.e.

for reform in the area, is the “functional integration” of the study of mathematics with other disciplines and practical life.

Some of the most important attempts in applying such an integration include the projects: Applicable Mathematics (See; 13), Mathematics in Society (MISP) (See;10) and Integrated Mathematics, Science and Technology (IMaST) (See; 2). Although these attempts could be criticized on both theoretical and technical grounds, their essential problem, from our view, is that educational systems, in general, and the other supra systems, have not yet been sufficiently equipped for introducing relevant changes. This is applicable to many different issues, starting from the concepts of education and mathematics education to societal involvement into education up to the impacts of the process of globalization.

Further Considerations for Reform

Coming to the conclusion that “functional integration” of the study of mathematics with other disciplines and practical life might be the key point for reforming mathematics education, a relevant further discussion becomes crucial. The following are some essential considerations in such a direction:

1- Going through the story of science reveals that one of the major reasons for the fading of both the Greek and Roman science is the separation between theory and practice, as experimental science had been condemned under their dominating slavery systems (See;5:47- 52)⁽³⁾. The lesson which we should learn from this is that any knowledge is meaningless when it is separated from its applications.

2- If we consider decision making at different levels as the immediate use of knowledge, we should keep in mind when dealing with mathematics (as being integrated with its applications) the methodology of decision making and/or the new paradigm of science, i.e. complexity, with transdisciplinarity and uncertainty as some of its characteristics (See; 8). Some of the consequences of complexity on mathematical thought, and therefore on mathematics education, are:

(i) Unity of inductive and deductive thinking, due to the fact that ‘experimentation is subjected to prior mental construction’ and to the role of “selecting of the mathematics” to deal with a scientific problem (1:42).

(ii) Mathematics cannot be seen as merely a language, that is “mathematics efforts has become the core of discovery, and it gives alone the chance to think about the phenomenon” (1:56)⁽⁴⁾. Nevertheless, the “language” of teaching mathematics, as a part of “ethnomathematics”, is subject to differentiation among different cultures (See;3).

(iii) As referred to above, rejecting linearity (See; 8).

(iv) Giving an essential role to “modelling and simulation” in “school mathematics”⁽⁵⁾.

3- In such a framework, functional integration could take the “functional encyclopedism” model, where collecting data for dealing with any problem or issue, of multiple or transdisciplinary nature, will take “an encyclopedism” form, with regard to the availability of knowledge (See; 7).

Keeping in mind the above discussions and considerations, we actually need a new movement calling for “new mathematics education through new curricula” . To achieve that, it is required to have a collective creative work of mathematicians and other scientists including social scientists, mathematics educators and other concerned community agents. Most important is the fact that this work must be associated with introducing radical changes in systems of education and their supra systems. The resulting outcomes, of course, will be subject to a great variation among different societies.

Notes

(1) These forms are: Verbal/ Linguistic, Musical/ Rhythmic, Logical/ Mathematical, Visual/Spatial, Bodily/Kinesthetic, Interpersonal and Intrapersonal (See;4).

- (2) To avoid much repetition in wording, each phrase starts with the “call/ slogan /ideal situation”, then it is contrasted with the dominant actual situation.
- (3) With a sharp distinction between mental and manual work.
- (4) To explain this, the author quoted Langevin when saying “The tensor calculus defines physics better than the physicist himself”, concluding that “new knowledge is impossible without the domination of this new mathematical means” (1:56).
- (5) The writer is influenced in this respect by his discussions with Prof. Ali Nassar.

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