Mathematics Education and Comparative Studies: Two Examples

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Abstract

The 'Meraner Reform' of 1905 in Germany and the IEA mathematics study of 1967 are examples of the changed perception of the meaning and uses of comparative education: a rather narrow, utilitarian approach to school practices was succeeded by successful cross national research emphasizing its potential for extending fundamental educational knowledge on a global basis.

1 "Meraner Reform" of 1905 in Germany

The "Meraner Reform" of 1905 in Germany was the greatest and most successfull reform in the history of teaching science and mathematics (Gutzmer 1908). The curriculum and the methods of teaching in these subjects were modified. The concept of function, descriptive geometry, coordinate systems and analytic geometry, differential and integral calculus were introduced into the syllabus. Physics lessons were characterized by an accentuation on experiments and other student activities. The "Meraner Reform" is a result of the political and economical background (Inhetveen 1976; Bruhn 1983) *and* of comparative studies.

With the development of national school systems in the nineteenth century, scholars were prompted to study aspects of schooling abroad (Brickman 1960; Fraser & Brickman 1968). A fundamental assumption was that selected features of school administration, staffing, instructional methods, and curriculum could be imported into their own country. These studies (in former times the term 'Auslandspädagogik' was often used to describe these kind of studies in Germany) were the result of the author's travels abroad and reported observations, conversations, and the study of relevant documents. Americans,

for instance John Griscom, Calvin Stowe and Horace Mann, came to Europe to learn about schools and the work of European educators. European school administrators also visited other countries. Victor Cousin from France studied education in Prussia and the Netherlands, Matthew Arnold from England went to Germany and France. The German Karl T. Fischer (1901) studied the English school system, especially the methods of science teaching, because H.E. Armstrong had introduced new methods in this field. Ernst Grimsehl, also German, inspected appropiately the French school system (Grimsehl 1912). Their publications described entire national systems, parts of these systems, aspects and styles of schooling, as well as methods of teaching. They used historical concepts, historiographical and documentary techniques, philosophic speculation, and manifested pedagogic understanding: *Foreign examples are a basis for successful changes in educational systems. Comparative studies are necessary, but not sufficient for successful reforms*.

Such a pragmatic use of comparative studies may not be equilized with uncritical cultural borrowing. The educational system can be perceived as a configuration that can only be explained in terms of the unique historical and cultural traditions in which it is imbedded. But already in 1902 Sir Michael Sadler (1902) stressed two views of comparative education. First, he claimed that the practical value of studying other systems of education, should be that a great deal can be learned about one's own system of education. The second claim was that what goes on outside the classrooms may be perhaps even more important than what is observed inside them. External conditions, aspirations, and resources are to be viewed as both determinating and justifying internal school arrangements. Comparative studies have "to explain educational principles and tendencies in terms of social, economic, and political antecedents of each country under considerations" (Sandiford 1918). A third idea should be added. The educational system and its changes can be regarded as an integral part of the 'fabric' of a society. Studying nations' educational thought and practice, can be seen as a way to understand social dynamics and general patterns of development of institutions and ideas in education (see e.g. Hans 1949; Kandel 1933; Ulich 1961).

2 Reform of Mathematics Teaching in Europe in the '50s and '60s

At the end of the '50s, the Organisation for European Economic Co-operation (OEEC) took an interest in education as a form of investment which could contribute to economic growth; Education was considered as a national

investment in its future socially, politically, and economically. In this context the Royaumont Seminar of 1959 (OEEC 1961) was an important step. It was the most important conference of the OEEC for modernisation of mathematics teaching on the basis of formalistic structural mathematics (Bourbakism) with Dieudonné's famous "Euclid must go!" Psychologists and mathematics educators emphasized the analogy between mathematical structures and the Piagetian psychological stages of development. However, only three years later problems with the 'New Math' were visible (see e.g. Freudenthal 1962, 1963).

The reform of 1959 was not attended by comparative studies. The OEEC report on school mathematics in OEEC countries is only a collection of data, and therefore of limited merit. It involves descriptions and no analytic comparisons, despite the fact that in the meantime, the comparison of one system with another had reached a high level. One stream of comparative work occupied itself with the interaction of educational and political, social, or economic systems: As school's primary objective deals with education, it fulfills instructional functions and demands attention to comparative studies, for example family, religious organizations, politics, and communications media, including a wide range of ideological views and attitudes. Thus, schooling cannot be examined without reference to its cultural setting. Another stream focused on particular pedagogical factors, namely comparisons of instructional methods, curricula and teacher training. International investigations of school and other educational factors affecting student achievement had become feasible, as a result of advances in methodology and technique.

The works of the International Association for the Evaluation of Educational Achievement (IEA) are very good examples of comparative research that seeks to enlarge the state of pedagogical knowledge about the factors that account for differences in students achievement on a global basis. They are marked by

- placing primacy on the careful identification, validation, and measurement of variables;
- showing the relationships among those variables within each country;
- comparing cross-nationally the direction, size, and confidence levels of statistics measuring these relationships.

The assumptions of these works are the concepts underlying statistical and empirical methods in the sciences, the view that educational and social phenomena are results of multiple causes, that there are regularities or tentative laws, and that these are discoverable through systematic collection and analysis of the relevant data. But empirical quantitative comparative studies of education are also disciplined through research theories and methodologies of philosophy,

history, and the social sciences. They help in collecting and presenting data, making inferences, and asserting conclusions (Noah & Eckstein 1969).

The six-subject survey of education in 21 countries conducted by the International Association for the Evaluation of Educational Achievement (IEA) constitutes one of the successful attempts at cross-national investigation in terms of research, generation of primary data, and analytic conclusions. One of these is the first IEA mathematics study (Husén 1967).

This IEA mathematics study was especially criticized by Hans Freudenthal (1905-1990) (Freudenthal 1975a, 1975b). He referred to some problems of such studies, such as finding and definitions of variables, comparability of these factors in different countries, problems of interpretation of correlation and regression if it is uncertain that the main variables are part of the analysis, etc. In a formal sense he was within his right. The use of statistics in complicated systems is full of problems; perhaps there is no statistics of this kind that can't be criticized. The argument that national educational systems can only be understood in terms of the unique configuration of events that produced them is unassailable. It is also true that each subject - e.g. mathematics - has features which principally can not be conceived by comparative studies.

In Freudenthal's view (1991), mathematical concepts, structures, and ideas serve to organize the phenomena of the real world, as well as of the field of fully developed mathematics. He conceived learning and developing mathematics as an ongoing process of mathematization on different levels and into different directions: basic activities within this process are local and global ordering, schematizing, formalizing and symbolizing, and - most important - deliberately reflecting and communicating these activities. Therefore teaching and learning have to start from rich contexts in which mathematics could be studied and experienced in use or on work. The applications of mathematics play a major role in his conception, in contrast to reform movements like 'New Math' in which applications - for systematic reasons - were almost completely neglected and pushed aside. Learning mathematics, in his view, is necessarily based on exchange with others, and consequently social interactions became an indispensable precondition. The interface between individual and collective experiences must be enforced by intensive communication and experimental work in heterogeneous groups: Mathematics as a human activity at various levels within the lived reality. In this view of mathematics the question of pupils' achievement in mathematics is not very important. Freudenthal's serious criticism of all kinds of systematic conceptualization of mathematics education and learning mathematics is directed in the same way against 'New Math' and the achievement study of IEA. His argument is that a closed, systematic and

deductive approach would necessarily determine and suffocate the education process.

Therefore Freudenthal's review of the IEA mathematics study is not a kind of fault-finding, but a positive contribution. He shows that not all aspects of mathematics education can be grasped by comparative studies and that the view to a subject determines the answer to the question, whether the content or the methods of research are important.

But there seems to be also a contradiction between deliberately rejecting a systematic structure to the field and the requirement of organizing patterns, at least for explanatory purposes. We are also within our rights when we say: *Comparative studies are an important integral part of mathematics education which cannot be neclected, e.g. the insight into different dimensions of attitudes to school mathematics and how they are related to other factors, especially achievement. There is no doubt that mathematics teachers must also be conscious of the changing nature of the wider society outside school and its influence on mathematics curricula, attitudes, pupils' achievement, etc.*

One important difference between comparative education writing in the nineteenth and beginning of the twenthieth century (example 1) and the work of the second half of the twentieth century (example 2) lies in a changed perception of the meaning and uses of comparative education. A rather narrow, utilitarian approach to school practices was succeeded by a more comprehensive approach to schooling, teaching, and learning as a system, emphasizing its potential for extending fundamental knowledge about the dynamics of development, science, mathematics, school, and special subject in schools.

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