

Mathematics, Culture, and Authority

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This article deals with the interaction between mathematics instruction on the one hand and established cultural patterns of belief, thinking and behaviour on the other hand, especially in Third World countries. The article points to the importance of culture in influencing the way people see things and understand concepts, and to the importance of using cultural and societal sources and personal experiences in making the teaching of mathematics more effective and more meaningful, as well as to the ways in which mathematics can be used to deal with some drawbacks in one's own culture and society. In addition, the article points out the conflict that usually arises between existing authorities and the teaching of mathematics when the latter is taught in such a way as to enhance critical thinking, self-expression, and cultural and social awareness. The region under consideration is the West Bank of Jordan (Eastern Palestine) where I spent my school years and over fifteen years as a mathematics teacher and educator.

Some questions

Is it true that mathematics is a neutral subject independent of a culture with its existing patterns of belief and behaviour, and its intellectual structures?

Is the teaching of mathematics different from the teaching of history?

Should mathematics be taught in an abstract and detached manner, or in a way which is more subjective, personal, and full of meaning?

Is it possible to teach mathematics effectively – i.e., to enhance a critical attitude of one's self, society and culture; to be an instrument in changing attitudes, conviction, and perspectives; to improve the ability of students to interpret the events of their immediate community, and to serve its needs better – without being attacked by existing authorities whether they are political, religious, or any other form?

Why is mathematics never, or at least rarely, taught to be useful in Third World countries?

Why are most students who major in mathematics in these countries usually "conservative" in their social outlook and their behaviour and "timid" in their thinking and their analyses?

What should be the objectives of teaching mathematics in Third World countries and what can be done to achieve them?

In this paper, I will discuss answers to some of these questions in the context of what I experienced in one small region.

Background

The communication is an outcome of a personal experience in teaching mathematics for over fifteen years at different levels, but mainly out of the experience I had as the Head Supervisor of Mathematics Instruction in the West Bank for five years (between 1973 and 1978). My job was mainly to introduce and implement a new curriculum in mathematics in that region with its very unique circumstances. The region included over 800 schools and more than 1600 mathematics teachers. The population consisted of about 3/4 of a million Palestinian Arabs. The region was under the British rule prior to 1948, under the Jordanian rule till 1967, and under Israeli occupation since 1967. Politics and political problems are a way of life, and the social patterns of thinking and behaving, on the whole, are traditional and conservative. This made my work very difficult, but very interesting and not without problems and troubles. As an example, an educator usually has to deal with one authority; in the West Bank I had to deal with four "authorities": the Israeli military occupation; the Jordan government (through the syllabus, general exams, and the fact that the population carry Jordanian passports); the traditional and conservative institutions and segments of the population; and the national aspirations and needs of the people in the region.

The first part of the new syllabus to be implemented was a "blind" copy of the New Math materials in Western countries. It was written (through the initiative of UNESCO) for the tenth, eleventh, and twelfth grades in the Arab states, by people many of whom are foreign to the area and know nothing of its culture. I was in charge of implementing the new syllabus in the schools of the West Bank. Six regional mathematics supervisors and many interested and enthusiastic teachers actively assisted in implementing the new syllabus. The first course of training teachers (which included over 200 teachers) was initiated and run by Birzeit University in the summer of 1972. It was followed later by similar courses for teachers in lower

grades through the Technical Educational Office in Ramallah.

Objectives of teaching mathematics in Third World countries

Mathematics in Third World countries (at least in mine) is usually taught as a set of rules and formulas that students have to memorize, and a set of problems – usually nonsensical to students – that they have to solve. [1]The only reason for studying mathematics for most students is to pass the examinations. Though the cited objectives of teaching mathematics usually assert knowing certain mathematical facts and being able “to think correctly, logically, and scientifically”, among other objectives, I came to believe that the main objective of teaching mathematics (or any other subject) in developing countries, is to doubt, to inquire, to discover, to see alternatives, and, most important of all, to construct new perspectives and convictions. One of the main objectives of teaching mathematics should be to realize that there are different points of view and to respect the right of every individual to choose his/her own point of view. In other words, mathematics should be used to teach tolerance in an age which is full of intolerance. The objective of teaching mathematics should be to discover new “facts” about one’s self, society and culture; to be able to make better judgements and decisions; and to build the links again between mathematical concepts and concrete situations and personal experiences. All these – in my opinion – are necessary for a balanced development of any country or society.

Mathematics teaching in action

In this section I will mention some examples from my experience that bear out the nature of the objectives cited in the previous section.

1. A first grade teacher put a chart with days, and squares next to each day, at the corner of the classroom. Every day he would cross a number of squares, next to that day, equal to the number of students absent on that day. After about a month, the six to seven year old students noticed that the biggest number of absentees occur on Saturdays. The teacher asked about the “reason”. An interesting and heated discussion followed. One student said, “because it comes after Friday”, (Friday is the official weekly holiday). Another student said, “The kids like to spend Saturday at home because their fathers are at home.” (Some men from that village work in Israel and so Saturday is their day off.) A third student gave as a reason, “the poor transportation on Saturdays due to the fact that some workers don’t go to work on that day”, etc.

Now, why is such an example worth more than a whole book of routine and dull exercises?

First, such an example deals with a problem that is familiar and interesting to the students simply because they are living it. Second, the problem is new to all of them, including the teacher. Such an experience makes the students feel that they are “equal to the teacher”; they are both dealing with the unknown, so to speak. Third, it breaks a certain cultural belief which exists very strongly

in our society. The belief is: there is only one “correct” answer to every question or problem, and that answer is given by “authority” (in this case the teacher); all that the students have to do is to memorize these answers at least until the day of the examination. According to this belief or pattern, there is no dialogue and there are no different alternatives or points of view. Through an example like the ‘biggest number of absentees’ problem, the students actually share in the education process: they give and not merely receive ideas and opinions.

Fourth, the students, through such an example, realize at this early age the importance and usefulness of collecting data and putting it in an orderly form. This is especially important in a community that doesn’t believe in experimentation and collecting information as a means to knowledge. They learn to be patient if they want to get results and arrive at conclusions. Such an experience convinces them that mathematics can be used to discover “facts” about the community and make judgements.

Fifth, the children realize early in their lives that there is a big difference between a “fact” and its interpretations. “The biggest number of absentees occurs on Saturdays” is a “fact”. But that fact has many interpretations and explanations, as the answers of the children themselves showed.

Sixth, such an experience helps change the attitudes of students towards knowledge and learning in general and towards mathematics in particular. It helps create a healthy relationship between students and teachers which is not authoritarian or parochial but rather dynamic, interactive, in addition to instilling confidence and self-respect in the students.

2. Two examples follow from mathematics for illiterate adults.[2]

(a) A class, which consisted of women only, was asked (early in the course) to keep a daily record of the time each woman spent in cooking, cleaning, washing, taking care of the children, etc., for at least a month. What would the women learn from such an experience?

First, they learn to put the information in a tabular form. They use addition and multiplication to get to certain conclusions. In short, they learn and use some topics in mathematics in a practical setting.

Second, the women have a much clearer picture of themselves, their lives, their roles, and the meaning of being a housewife. If a husband shouts at his wife at the end of the day, “What have you been doing all day?”, she can show him details of the many jobs that a woman usually has at home every day, seven days a week, all year around, all her life and in almost all cultures.

(b) In the summer of 1979 I taught mathematics to a class of illiterate workers in Birzeit University. They had had some classes of Arabic but none in mathematics. In the first period of teaching that class, I started by asking some general questions. One question was, “Suppose a friend wants to come and visit you here but he doesn’t know the place. All he knows is where the post office is. Draw a map for him showing the way from the post office to this building.” What took place in that period still thrills me. As a response to the question mentioned above, each worker drew a map from the post office to the class-

room. The maps were all different from each other (four of the maps are shown in Figure 1).

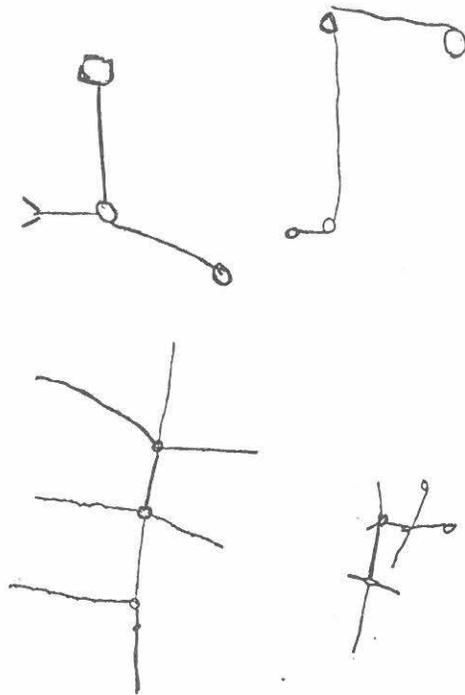


Figure 1

One of the workers commented, "How come they are all different although we have all drawn the same road!" Another worker replied, "But each of us understands his own map." A third worker said to the one who drew the lower right map, "Why did you draw the road to be straight although it is not straight?" To which the other replied, "When I walk from the post office to where we are I walk straight here!" The discussion that took place in that first period pointed to things that I never thought of or realized when I first asked that question. We talked about the meaning and importance of conventions in understanding and communicating with each other. We talked about the different meanings and uses of the word "straight" in Arabic (which is also true about the different uses of this word in English, and I suppose in many other languages too). We talked about the importance of being able to use a map, and so on. Later that day I felt that that class was probably the richest class I gave in my life; and supposedly to illiterates! In the process of trying to teach, I was busy learning and reacting. I was completely involved. I was convinced more than ever that students (whether they are children or adults) are not empty shells to be filled with our wisdom and knowledge; rather, they are full of experiences and ideas, and they have their own personal ways of looking at things. As teachers, we should start with these experiences and personal viewpoints in our teaching. The first reaction I had when I saw the drawings was to say, "They are wrong". I am glad I didn't.

3. Teaching sets to a seventh grade class for the first time.

I brought cards that had five holes punched in a row along the top. Each hole corresponded to one of five questions that I wrote on the board. The answer to each question was either "yes" or "no". If the answer was "yes", each girl was instructed to keep the hole on her card corresponding to that question unchanged. If the answer was "no", she had to make a notch above the corresponding hole on her card. As an example, one of the questions was "Are you a member of the public library?"

The 32 girls in that class, and on that first day, learned a lot about each other. They learned for example, that only six girls were members of the public library in town. An interesting discussion about the reason for the small number of members followed. In addition to the information they got about their small "community", they also learned about the uses of such "computer" cards in companies, firms, etc. Also, the girls were introduced to some mathematical concepts about sets. For example, through the question, "How many girls who reside outside town are members of the library?", intersection of sets was introduced. And through the question, "How many of the new girls in the class are members of the library?", the empty set was discussed. And so on.

4. Deductive thinking[3], historically, has helped to support the belief in "absolute truths" and the existence of one "correct" answer to each problem. The axioms of geometry, for example, were considered for a long time to be true innately, naturally, and *a priori*. They were considered to be familiar to every thinking creature and true in all possible worlds, thus making the possibility of seeing alternatives very difficult, if not impossible. Although mathematics and most mathematicians have moved away from such an "arrogant and naive" point of view, still mathematics is being taught as if its statements are absolute and eternal. Unfortunately, this same attitude exists also in domains other than math, such as the social, religious and political domains. Thus the teaching of deductive thinking traditionally supported the "dogmatic" dimension in education.

However, through my experience with schools and in Birzeit University, I came to believe that deductive thinking can be used very effectively to create new attitudes and awarenesses towards knowledge in general and towards math in particular – awarenesses and attitudes that are very much needed in our society and culture and I imagine in other societies in Third World countries too.[4] First, students learn that math is man made. They learn that axioms are not God-given or Nature-given, but rather they are statements that evolve with time and through a long and hard process. They learn not only that basic statements evolve, but also how the meanings or words and concepts (such as axiom) evolve. Second, students learn to see similarities among things that do not seem similar at first sight. Realizing that the two diagrams in Figure 2, for example, could be considered as models of one and the same abstract system (by interchanging the meanings of "line" and "point" in the axioms of the system) was always shocking and interesting to the students and a source of a serious, deep, and involved discussion that usually lasted several periods. In my experience, this kind of in-

teraction broke many prejudices and rigid ways of thinking. Third, students learn an intellectual model or structure – the axiomatic model – which is missing in our culture. Fourth, it helps students see alternatives and the meaning of “relatively true”. They learn that axioms can be completely or partially changed to produce new systems and models. Fifth, it helps students relate a certain event or phenomenon from the real world to many possible abstract models; and vice versa, one abstract system can have twenty “concrete” models or applications in the real world. Sixth (which I believe to be the most important point), it increases the awareness, on the part of the teachers and students, that most, if not all people are logical. The difference among different people lies either in their basic assumptions or in the “logic” they use or in both. Accusing a student of being illogical leads to feelings of worthlessness in the student and makes the teacher miss the opportunity of understanding that student and of expanding his/her (i.e. the teacher’s) “treasure” of mental images and structures. With that in mind, the question becomes, not whether a certain person is logical or not, but rather what are the assumptions and type of logic that that person is using. The question also becomes, not only what type that person is using, but also how that person came to accept or adopt that logic (e.g. by force, by custom, by critical reflection, and so on). That does not mean that all logics and all assumptions are equally effective in understanding and dealing with a specific problem in a certain situation. All it means is that different assumptions and different logics are needed at different times and in different situations; there is no perfect logic that is good for all times and for all situations. Thus in our teaching we should try to arm the students with different types of logic and with the confidence to choose which they feel to be appropriate.



Figure 2

Culture, the individual, and the teaching of mathematics

A common misconception in the teaching of math has been, and still is, the belief that math can be taught effectively and meaningfully without relating it to culture or to the individual student. This, and not the difficulty of the subject, in my opinion, was, and still is, the main reason why math is considered meaningless, incomprehensible, and not a popular subject by the vast majority of students. In this section, I will discuss further the interaction between culture, the learner, and the teaching of math.

It has been a general belief that the teaching of math is different from the teaching of history or sociology or political science. Such a belief asserts that in the latter subjects there are different points of view, while in math “facts” are true irrespective of culture or of the individual

or of time. I came to believe that this is a very misleading belief that affects our teaching of math negatively. “The First World War took place in the period between 1914 and 1918” is a historical fact, but its description and interpretation differ from one person to another and from one nation to another. Similarly, I believe, “one equals one” is a mathematical fact, but its description and interpretation and application differ from one situation to another and from one culture to another. A fresh and delicious apple is not equal to a rotten apple. A certain chair is not equal to another chair in all its details no matter how identical they seem to be. (I asked this question about two similar chairs to my son who was ten years old, “In what way are they equal?” After some discussion he said, “They are equal in name”, i.e. in being called “chairs”.) No person is equal to himself the next day. One dollar in 1970 is not equal to one dollar in 1980. And so on. Strictly speaking, then, “one equals one” does not have true instances or applications in the real world.

The truth of the matter is that in schools and in all our teaching we keep the world of reality separate from the world of abstraction (with the exception of some trivial and irrelevant examples that are scattered in textbooks under the misleading title of “applications”). In the world of abstraction, we usually agree about “facts”; but in the real world, we face many interpretations and meanings and ways of looking at these facts; so we argue and we fight. People, for example, agree that one equals one is true in abstraction, but antagonistic feelings and different opinions emerge when we say for example that “women are equal to men” or when we say that “one vote for Jordan (with two million people) in the U.N. is equal to one vote for the U.S. (with 200 million people) in the U.N.”. Teaching with meanings and by relating the abstract world to the real world makes math more relevant and more useful. In addition, it helps students appreciate remarks such as Einstein’s often cited remark, “As far as the laws of math refer to reality, they are not certain; and as far as they are certain, they do not refer to reality”.

Culture influences the way people see things and understand concepts. In Arabic, for example, there are more than one hundred names for “camel” (each name describes the camel in a different position or mood). In English there is but one word for camel. On the other hand, there are hundreds of words in English for flowers (each word describes a certain kind of flower) while there are only two or three words in Arabic for flowers. Similarly, there are many words for ice in the Eskimo languages (each word describes ice in a different form, use or setting), one or two words for it in English or Arabic, and no word for it in some tropical languages. The Arab’s concept of camel is much richer than the others; the Briton’s concept of flower is much richer than the others; and the Eskimo’s concept of ice is much richer than the others.

I read once about a place where the people do not differentiate between yellow and green. They have only one word to describe “both” colors. I was amazed, “Can’t they see the difference?!” Then one day I was describing the color of a car as green to a Frenchman. He said, “But it is

turquoise!" For him there were two colors with two different names. For me there was one color with one name.

Another example. Once, a number of us at Birzeit University were trying to find a word equivalent to the word "privacy". Five people agreed on one term, the other three held the view that, strictly speaking, "privacy" has no equivalent. We debated the issue for a long time. Later we noticed that the three who had difficulty in finding an equivalent for "privacy" in Arabic had all lived for some time in the U.S. and thus had an "experiential" meaning of "privacy" as it is understood in the American context, while the other five who found the term satisfactory got it from a dictionary or learned it in school (and have never lived in the West). The two words evoked the same meanings and images and experiences in the minds of those who never lived in the West, and different meanings in the minds of the three people who lived in both cultures. "Privacy" in the way it is practiced in America, is never experienced in an Arab society, which is essentially a "communal" type of living.

One more example. There is one word ("raqam") in Arabic for the two words in English: "numeral" and "digit". This created a confusion between the two concepts in the minds of most teachers and students whom I worked with in the West Bank, reflected in the statements that they expressed in relation to these two concepts.

The Arabic language, on the other hand, can be used very effectively to help the students to think critically and within context. To borrow a remark made by an Arab thinker, "Usually in other languages you read in order to understand; in Arabic you have to understand what you are reading in order to read it correctly". Many words in Arabic can be read or pronounced in as many as eight or ten different ways depending on the context. Thus one has to understand the meaning of the word in order to read it correctly. It is unfortunate, however, that Arabic is taught in schools as a set of ready-made statements that are repeated for hundreds or thousands of times. Under such conditions, the ears of the students – and at best their tongues – work, but their minds are kept "safe" from thinking.

If culture determines the way we see a camel, and the number of colors that exist, and how accurate our perception of a certain concept is, may it not also determine the way we think, the way we prove things, the meaning of contradiction, and the logic we use?!

Just because the same word or symbol is used for camel by different individuals or by different nations, we cannot conclude that they have exactly the same concept. And just because we use the same symbol for the number "one" in the same classroom or in different classroom, that does not mean that the same images pop up in the minds of the children. We unify the symbol but mistakenly conclude that the meaning and the images are unified. This fact is often ignored by the teachers and educators of math. When a word such as "area" or "proof" or "axiom" is used in a math class, teachers do not pose questions to know what are the meanings and the images that are created in the minds of their students. Math teachers are

usually satisfied if students use such words "correctly" in a purely mechanical way.

The world is heading to a peak of cultural changes and cultural awarenesses. Math can be used to stress one's own culture with its special and beautiful characteristics. At the same time, math can be used to make one aware of the drawbacks in one's own culture and try to overcome them. In other words, math could and should be used to point out the strengths and weaknesses of one's own culture. (I have always read, for example, that the Arabs and Moslems contributed a lot to math and the sciences, one of their contributions being the solution of the general cubic equation. However, the curriculum never showed me how they did it and western historians in general have denied this contribution by the Moslems.[5]) Teaching math in a way detached from cultural aspects, and in a purely abstract, symbolic and meaningless way, is not only useless, but also very harmful to the student, to society, to math itself and to future generations.

It should not be understood from the above that math should or could be taught within one culture separate from other cultures. Advances in thought in one culture should be understood and welcomed by other cultures. But these advances should be "translated" to fit the "borrowing" culture.[6] In other words, to import ideas is acceptable and should be encouraged, but the meanings and implications of these ideas should be "locally made". That is what we do, for example, with a refrigerator when we import one from France to our country: we fill it with Arabic food rather than with French food.

Not only local and cultural meanings should be encouraged, but also personal feelings and interpretations, which are just as important, especially with little children. We should encourage in the children "subjective" ways of looking at mathematical expressions and concepts as much as objective ways of understanding them. We should not stress one and forget the other. One of the most beautiful and revealing definitions of a point I ever heard came from a six-year old girl. When asked how she saw a point, she said that it is a circle without a hole. That definition involves the concept of limit in math. A teacher who lacks the imagination of that child may be unable to understand what she was talking about.

We have to encourage children to "see what they mean" and not only "what we mean". Numbers and symbols and words we use with children are never meaningless to them, and these symbols don't mean only what we mean by them when we mention them or use them. Children have their own personal likes and dislikes about symbols. These likes and dislikes become, in some cases, strong emotions and convictions. These things are usually ignored by math teachers and educators. We have to ask questions, to little children in arithmetic classes, such as, "Which do you like better, five or two, and why?", and not only questions like, "Which is greater, five or two, and why?"

In Third World countries we should be careful not to follow the Western way of interpreting objective knowledge as being purely abstract, absolute and detached. In teaching a mathematical concept or "fact" we should ask for ex-

amples where that concept or fact is applicable or true and where it is not; we should ask about some of the uses, misuses, and abuses of that concept or fact. We should ask for personal and cultural meanings of that concept or fact rather than just ask the students to memorize it or to solve routine problems concerning it. Math can be used to help students relate, organize, see alternatives and make better decisions. We as teachers and educators of math should find ways to accomplish that.

Authority and the teaching of mathematics: conflict and trouble

One very important aspect of any culture is what constitutes authority in that culture and how that authority reacts to and deals with people when they think in a critical way or in a way that deviates from the "correct" path. My own experience, and the experience of many others that I knew or read about, made me increasingly believe in the following conviction: in spite of the claim by educational institutions and by authorities that control these institutions that they encourage free and critical thinking, such educational institutions, in general, discourage critical, original, and free thinking and expression, especially when that touches upon "important" issues in the society. Students who ask relevant questions about important events in the immediate community and see new alternatives and seek new interpretations of what exists are usually considered to be very "dangerous". Teaching people to question, to doubt, to argue, to experiment, and to be critical, and teaching that increases the awareness of students, constitute, in my opinion, the real threat to existing and established institutions, beliefs and authorities everywhere and of every kind.

People who engage in teaching in this way are the subject of all kinds of familiar accusations, from disturbing law and order, to teaching corruptive and immoral ideas, to being a threat to national security; and eventually they are forced to stop teaching, to say the least. Socrates was accused of this in "democratic" Athens in ancient times, and Oppenheimer and Eldridge Cleaver were similarly accused in "democratic" U.S. in modern times. This is also true for socialist and Third World countries. The rule underlying such a response seems to be that if a questioning attitude is fostered in teaching, this may lead to a questioning of other things in society, including authority and the underlying assumptions and structures of that society.

Anyone who has never experienced this and who doubts it should have a second look at his/her own teaching and try to find out how much it is related to important issues. I mean by "important" those which are related to matters that control the economy, technology, politics, religion, ethics, suppression of certain groups – whatever is considered to be of prime importance in that society. I have encountered this type of experience many times. One such situation arose in forming math and science clubs in high schools in the West Bank. Students were free to choose any experiment to perform or any topic to gather information about and to discuss. The clubs lasted beautifully and successfully in many schools for almost two years. They

were much more successful, however, in girls schools than in boys schools. Female students were, in general, more receptive to new ideas and more inquisitive, sincere, independent, persistent, interested, and original than male students. Most administrators and teachers bet that the clubs would die or cease to exist in few months. They were right as far as the boys schools were concerned: within six months all the clubs in boys schools ceased to exist; but in some girls schools clubs continued to be active for about two years. They only ceased to exist because of the constant attacks, harrassments, and hostile attitudes that began to mount from two directions. Both the Israeli authorities and fanatical conservatives among the local Arab population fought the existence of these clubs – each for its own reasons and in its own ways.[7]

In short, I came to believe that the teaching of math, like the teaching of any other subject in schools, is a "political" activity. It either helps to create attitudes and intellectual models that will in their turn help students grow, develop, be critical, more aware and more involved, and thus more confident and able to go beyond the existing structures; or it produces students who are passive, rigid, timid and alienated. There seems to be no neutral point in between.

Schools in Third World countries (at least in mine) in their present structure and form help produce students of the second type mentioned above. The classroom is highly organized; the syllabus is rigid; and the textbooks are fixed. Math is considered as a science that does not make mistakes; and its truth is considered timeless and absolute. There is one correct answer to every question and one meaning for every word and that meaning is fixed for all people and for all times. "Wrong" answers are not tolerated; students are usually punished severely (one way or another) if they make "mistakes". Teachers, in their turn, are also expected to perform according to a certain set of rigid expectations and they are punished if they don't. One second grade math teacher, for example, in order to evade punishment, explained the inability of some of his students to answer the inspector's questions by labeling them in front of the whole class as mentally retarded. When the inspector objected, the seven-year-old children volunteered to accuse each other of being retarded when any one of them made a mistake.

Organizing a number of ideas and statements in a coherent way so as to be able to see new order and new relations among these ideas and statements is strongly discouraged in schools. Causal statements and statements that express relations are usually to be memorized, but never to be discussed or questioned. Some examples are, "If we don't get enough rain, it is because some girls wear sleeveless dresses"; "Losing the war (in 1967) is a lesson for us from God." (That was in fact what Nasser of Egypt said after the war.); students give correct definitions of square, rectangle, and rhombus, but the relationship among them is hardly discussed or asked for. When my son was eight years old I asked him one day what he had learned in school that day. One of the things he mentioned was, "If you want to avoid getting sick, then you have to wash your hands before you eat." After a short time, he started eating

without washing his hands. When I reminded him of what he had just said, he told me he had merely to memorize that fact for the test next day.

Under all these conditions, it is not hard to see why most teachers and students who are attracted to math and the sciences, at least in countries that I'm familiar with, are "conservative" in their outlook, traditional in their behaviour, and timid in their thinking. The same conditions also explain why math is taught, almost always, in a detached and irrelevant way.

Summary and suggestions

1. The math teacher, the learner, their experiences, and their culture are extremely important factors in the teaching of mathematics and in making it more meaningful and more relevant. Teaching math without a cultural context, by claiming that it is absolute, abstract and universal, is the main reason, I believe for the alienation and failure of the vast majority of students in the subject.

In addition, teaching math through cultural relevance and personal experiences helps the learners know more about reality, culture, society and themselves. That will, in turn, help them become more aware, more critical, more appreciative, and more self-confident. It will help them build new perspectives and syntheses, and seek new alternatives, and, hopefully, will help them transform some existing structures and relations.

2. Teacher training courses and programs form a good starting point to move in the direction mentioned above. Learning new topics in math or new methods of teaching them is not enough to acquire insight and relevance – the two most precious qualities in the teaching profession. Teacher training courses and programs, I believe, should include also courses on culture, society, the relationship between language and thought, and the history of evolution of mathematical concepts among other things. No change in math curriculum is effective unless the teachers understand the change in all its dimensions.

We have to distinguish between superficial or formal success of a new plan or program or curriculum and a real success; between superficial change and real change. The new syllabus in math that was adopted by the Arab countries in the 1970's was "successful". You can see the change: new books, new topics, new symbols, new terms, and lots of training courses. But that is superficial change in my opinion. The real change which means change in attitudes, values, assumptions, relations and structures were completely missing.

3. Changing attitudes, values and basic assumptions and relations, however, are very costly to the teacher. There is a price for teaching math in a way that relates it to other aspects in society and culture which may result in raising the "critical consciousness" of the learner. And the price that the teacher usually pays varies directly with the power of authority (regardless of whether that authority asserts its power in a subtle or direct way) and with the effectiveness of the teacher. The fear of paying the price is one main factor, in my opinion, that diverted education from its "natural" course and forced it to take detached and meaningless forms.

4. To achieve some of the objectives cited above, I would like to suggest the following as one possibility. The suggestion is directed to any world organization with an interest in developing new programs in math such as UNESCO or the International Congresses on Mathematical Education.

Twenty or thirty educators from different cultures who are convinced of the importance of relating the teaching of mathematics with cultural aspects can start working on developing a syllabus based on this relationship. The strengths, weaknesses, misuses, abuses (and not only the uses) of mathematics in several cultures should be included in the syllabus. Different interpretations, perspectives, and examples of certain concepts in different cultures should also be discussed. Students who go through such a syllabus will, I believe, be able to understand themselves, their beliefs, and their culture better. They will also be able to understand other people and other cultures better. In addition, such a syllabus, I believe, will help "humanize" math by helping to bridge the gap between science and technology and other social and cultural aspects in society. Most important, it will help, I hope, in fighting three of the biggest evils in our time: absolutism, intolerance, and ignorance.

Notes

- [1] This does not mean that mathematics in technologically advanced countries is necessarily taught in a much better way. Many math books that I have seen used in elementary classes in the U.S., for example, require the children to "fill in the blanks" without any trace of real learning taking place.
- [2] Since 1976, I have also been involved in the teaching of mathematics to illiterate adults.
- [3] For one reason or another, the chapter (in the new syllabus) on axiomatic deductive thinking was omitted in many Arab countries.
- [4] As a result of these and other experiences, I devised a course that deals with some of the deficiencies in our schools and in our culture. The course attempts to relate axiomatic, deductive, and inductive modes of thinking to experiences that the students encounter in their daily life or in their intellectual questioning. The course was first taught to freshmen science students in Birzeit University in 1978. A textbook for the course (in Arabic) was published by Birzeit University in 1981.
- [5] I would like here to thank David Henderson of Cornell University who was a visiting professor at Birzeit University during the second semester of 1980/81 who first pointed out to me that it was Omar Khayyam and not Italian mathematicians who first found a general solution for the Cubic Equation. In fact, Dr. Henderson wrote a detailed exposition of Khayyam's geometric solution of the General Cubic Equation which was included in the course mentioned in Note #4.
- [6] There are, however, some cases in history (specially in relation to some conventions) where blind imitation proved to be better. Arabic numerals formed one such case. Originated in the East, they were written from right to left. (In expressing a natural number, we start with the units position at the extreme right and move leftwards.) And that is the way it is in almost all cultures that exist now. That makes it easier for different people to communicate "numerically". Can you imagine what would have happened if the Europeans decided to express natural numbers in a way consistent with their own cultures by starting with the units position on the extreme left?! On the other hand, the number line, being originated in the West, "grows" from left to right, and it is that way in all societies, which makes it much easier for people from different cultures to communicate "graphically".
- [7] I would like to mention one reason that I believe to be important in making the clubs succeed in girls schools but not in boys schools. The girls, in general, are outside the mainstream of society (which is true for most societies); so they found more meaning and relationship in "unorthodox" ways in education like the clubs' activities than did the boys.