

In this section, we will share your points of view on teaching and learning mathematics and your responses to anything contained in delta-K. We appreciate your interest and value the views of those who write.

What Is a Good Mathematics Teacher? How Do We Find One?

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The following article is a summary of presentations and discussions I conducted in North America and Europe when I was president of the National Council of Teachers of Mathematics (NCTM). It seems to be appropriate for me to recall some of these ideas for our many young teachers of mathematics. More details can be found in the Proceedings of the Fourth International Congress on Mathematical Education (Boston: Birkhäuser, 1983), pages 144–52.

Good teachers of mathematics use their knowledge and love of mathematics, as well as their love and respect for their students, to lead these students to enjoy the study of mathematics.

I have said nothing about students being successful, for I believe that students who enjoy the study of mathematics will learn mathematics and will be successful. My definition also makes it very simple to determine whether or not someone is a good teacher of mathematics. It is only necessary to discover the attitude toward mathematics of the students of that person. My definition of good mathematics teachers indicates that there are two key elements that will lead students to enjoy the study of mathematics. One is the love and knowledge teachers have of mathematics. The other is the love and respect teachers show their students. In other words, a personal relationship must exist between teacher and student, founded on the mutual respect they show each other.

How do good teachers of mathematics show their love and respect for their students?

My experience is with high school students. In order to show these students that I loved and respected them, I tried to give each one as much individual attention as possible. To solve the dilemma of doing this in classes of varying size, I used the Socratic method of teaching, which involves questions and answers—the questions being asked by both teacher and students and answered wherever possible by the students. This enabled me to ask most,

if not all, of the students one question each day. This question provided daily personal contact with each student. Ordinarily, half of the class time was given over to students working alone on problems. Again this allowed me the opportunity of personal contact as I went from desk to desk answering questions, praising good work, encouraging students and offering them hints. In addition, I was available before and after school to help students who had been away or who had difficulties that had not been cleared up during class time. In all of this, I found that praise and encouragement tended to help students try harder. Students want us to think that they are more than just students of mathematics, so I found that I could increase my personal relationship with students if I showed a genuine interest in their other activities—academic, cultural and athletic.

In the classroom, especially, the key to my effort to show respect was kindness—kindness to all students. Kindness is easy to give to someone who shows us respect. But kindness demands a true self-discipline on the part of teachers as they try to encourage students who appear to be unaffected by their efforts. Meanness, lack of work and rowdiness by the students must all be treated firmly but kindly. It is a slow and sometimes discouraging process trying to change students who dislike mathematics into being happy to be doing mathematics in one's class. Each year, I found students in my classes who only began to enjoy mathematics as the year was drawing to a close. The fact that these students did change

gave me the confidence that I needed to continue working with all students no matter how hopeless it might have seemed.

Students Must Learn Mathematics, Too

Yet, all of the kindness and respect for students will not help unless the students find that they are learning mathematics, sometimes in spite of themselves. Indeed, successful learning and doing mathematics are absolute necessities for any student who is going to enjoy mathematics. For every time a student solves a mathematics problem successfully, especially if success seemed impossible to the student, that student has made a giant step on the road to the enjoyment of mathematics. For this to happen, the teacher has to teach so that students can learn. There are many mathematical ideas that are difficult in themselves, but good teachers of mathematics are able to peel away the unnecessary complications and present the core ideas so that these ideas can be understood. (This is why a solid mathematics background is so important.) Good mathematics teachers, through their questions and explanations, are able to help all of their students to understand and successfully do mathematics.

The previous discussion of good mathematics teachers leading students to enjoy the study of mathematics makes two assumptions: teachers have the necessary knowledge of mathematics, and teachers enjoy mathematics themselves.

What Is the Necessary Academic Knowledge for Good Teachers of Mathematics?

In general, as a minimum, teachers of mathematics must know all of the material that they will need to teach as well as the place of this material in the spectrum of the mathematics curriculum. This process of learning mathematics is never finished for good mathematics teachers because they must continually learn—for example, through reading the national and provincial mathematics education journals such as the Ontario Association for Mathematics Education's (OAME) *Ontario Mathematics Gazette* and the NCTM's *Mathematics Teacher*, *Teaching Children Mathematics* and *Mathematics Teaching in the Middle School*; by attending conferences of the OAME and the NCTM; and by taking courses to keep their knowledge up to date.

How Do We Find Good Mathematics Teachers?

Much is demanded of good mathematics teachers. It is the obligation of the profession itself to see that mathematics teachers receive as much assistance as possible in their growth to become better mathematics teachers. If organizations such as OAME and NCTM are to be helpful to teachers at all levels (elementary, secondary and postsecondary), teachers must lead the organizations from all levels. One of the gravest mistakes that organizations like these can make is to think that such representation is not needed. Mathematics education associations will be most helpful if the articles in their journals and the talks at their conferences are given by teacher experts who are communicating with people at their own level—namely, elementary, secondary or postsecondary. I believe that teachers learn best from teachers who are experts at the same level. All of the goodwill in the world cannot make up for the fundamental error made in assuming that elementary teachers learn best about teaching elementary mathematics from secondary or postsecondary teachers, or that postsecondary teachers can help secondary teachers in their classroom practice. Teachers at the postsecondary level can and must assist elementary and secondary teachers to increase their knowledge of mathematics. It is only rarely that postsecondary school teachers are able to give worthwhile practical help, useful in the classroom, to elementary and secondary school teachers. Peers must aid peers. The good elementary school teacher must become an apostle assisting other elementary school teachers. The good secondary school teacher must be willing to share with other secondary school teachers. The good postsecondary school teacher must find ways to show other postsecondary teachers that good teaching is important and possible at that level.

The question now remains—can one help a given individual become a good teacher of mathematics? First, let me make some statements that follow logically from my definition and my discussion on it:

- Only a person with the required knowledge of mathematics for level X should become a teacher at level X.
- Only people who are happy should become teachers of mathematics.
- Only people who enjoy other people and want to help other people should become teachers of mathematics.
- Only teachers who want to become mathematics teachers should become mathematics teachers.
- Only teachers who love mathematics should become teachers of mathematics.

Note that this is a list of necessary conditions and not of sufficient conditions for determining whether or not an individual could become a good teacher of mathematics. In other words, no one lacking one of the five qualities should become a teacher of mathematics. But it does not mean that everyone who has these five qualities will become a good teacher of mathematics.

I believe that the best way to help someone with the necessary conditions to become a good mathematics teacher is to assign that person as an apprentice to an outstanding teacher. Many students who graduate from teacher-training institutions in mathematics are not ready to become good teachers of mathematics. Indeed, many of these teachers give up after a short time in the classroom. Those who do go on to become good teachers of mathematics usually have had much assistance from their peers who are good teachers of mathematics.

The real learning about teaching and about whether or not one should become a teacher of mathematics comes in the classroom. I firmly believe that one learns to teach by doing, not by listening. An apprenticeship type of training for beginning teachers would require “experts” to whom they would be assigned in elementary or secondary schools. These “experts” would need to be successful teachers who are currently teaching in their own classroom each day. A maximum of three teacher trainees would be apprenticed to each of these teachers for a minimum of one year. As in other apprenticeship programs, the trainees would be paid a nominal salary.

As I envision the program, the expert teacher and the trainee would be responsible for the same classes. Ample time would be set aside in the school day for them to prepare classes together, to decide what is to be taught, how it is to be taught, the questions that would be asked of the pupils and so forth. Some days the teacher would teach all the classes, and on other days, the teaching would be shared with the trainee. Time would be spent daily to discuss both the teacher’s and the trainee’s classes so that the trainee could understand the why as well as the how.

Conclusion

I was a teacher of mathematics for 47 years. During that time, I had many students ask me why I had been content to teach the “simple” mathematics of the high school level when I could be challenged more by university-level mathematics. They openly wondered why it was not boring to teach the same mathematics content year in and year out. My reply has been a simple one: “I teach students rather than mathematics.” Even though the mathematics did not change from year to year, my students did. Each year I had a new group of individuals to be with in my classroom. My years in the classroom were happy ones. I treated my students with respect, and they reciprocated. We all had much fun in my classroom, and we all learned. But my respect for the students was not enough for them. They needed to be successful. Somehow, in each of my classes, I was able to find something that every student could do well. I was fortunate in being able to do this in classes with four students and in classes with 45 students. The fact that my students learned, and that they enjoyed learning, brought me great joy.

Teaching students is difficult. Many people try it and cannot handle the one-to-one and many-to-one relationships that are part of teaching. Yet, too much emphasis is given to the difficulties of teaching. We must encourage our young teachers to look for more joy in their teaching. We must assure them that it is there. One of the reasons I think that apprenticeship is an essential part of teacher preparation is that it gives the teacher trainees an opportunity to share in the joy of teaching—a joy that some may believe does not exist.

As you proceed in your own teaching career, think about my definition, adjust it, change it, but think about it. Always remember the following: good teachers of mathematics use their knowledge and love of mathematics, as well as their love and respect for their students, to lead these students to enjoy the study of mathematics.

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