"I Have This Calculator; I'm Not Supposed to Have To Think"

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Abstract – The above title is a direct quote made by a freshman engineering technology student to our program coordinator in the classroom. While this statement is quite direct and one would hope isolated, educators across the country are aware that something is wrong with our educational system, particularly where math is concerned. This paper attempts to highlight the author's thoughts on some of the historical factors, existing K-12 academic environments, and present-day societal mindsets that might contribute to such an attitude towards mathematics, related science, or school in general.

Keywords: slide rule, NCLB, Sputnik I

INTRODUCTION

Each year, the United States continues to lag behind most of the industrialized countries in K-12 math and science scores. To fully evaluate and correct this situation would require years of research, evaluation, and implementation. Today, state school systems cannot even agree on the best way to teach our students. The questions are common. When and to what level should students be introduced to using calculators? Are students forgetting the basics? How are required standards going to be achieved? The real questions should be: Why are most children today not better at math? How did this decline in math skills occur? How quickly can we fix this? Is it the curriculum, the teachers, the testing system, parents not getting involved, or all of the above? It is this author's intention to highlight some major factors that he thinks contributed to the present conditions.

A BRIEF HISTORY

Historically, all school curricula have changed in the last fifty years. While change is normally good, it can also generate problems. When the Russians beat the United States into space on October 5, 1957 with Sputnik I, there was an initial outcry followed by a quick consensus across the country to get our students up to par, particularly in math and science skills. This triggered a national self-appraisal of scientific research and education in the United States. Congress responded by more than doubling the National Science Foundation's (NSF) appropriation to $134 million for the twelve months beginning July 1, 1958. Funding for education more than tripled [NSF, 8]. This resulted in NSF-issued grants to teachers of math and science, enabling them to get master's degrees in their subjects. The result would be better qualified teachers. In the early 1960s, the 'New Math' was introduced across the country. More emphasis was placed on 'concepts' in math, essentially setting aside math basics. This was the period when some parents could no longer understand their child's math homework. A decade later, in the 1970s, students were observed getting weaker in their ability to recall some of those 'old' basics, like multiplication tables. It should be noted here that calculators were not being generally used yet. Finally, as the 21st century started, the first concerns about students lacking basic math skills was starting to be voiced, notably in The New York Times [Lewin, 6]. Education officials began to seriously rethink the processes used in teaching math in our schools.

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IMPACT OF TECHNOLOGY

Advances in technology have been phenomenal since the slide rule. The calculator, access to computers and the World Wide Web (WWW) have generated changes in textbooks and how curriculum is taught. While teachers and administrators say they are about incorporating and using the newest technologies, some have been reluctant to adapt and utilize these devices within the classroom. Thirty years ago, a typical science report required a library visit, locating, researching / reading reference books, and then writing the report. What used to take days to complete can be accomplished in hours, depending on the student's expertise with the computer, software programs, and the WWW. While school assignments have been shortened, many educators believe that analysis, critical thinking, and writing skills have been the tradeoff for easy technological access. Freshman college students can input a formula into their calculator, execute the process and get an answer, but some cannot explain why or how the formula is used.

Is it the fault of calculators and other technology? Graphing calculators started making appearances in schools around 1989 and quickly became popular. They were supposed to help students visualize concepts that were difficult for students in the past. The downside to calculators is the belief that students' reasoning and thinking skills are being diminished. When the results from the Third International Mathematics and Science Study (TIMSS) were published in 2000, our eighth graders were in the middle of the ranking of the 38 participating countries [Holden, 4]. Noteworthy in the study was the use of calculators in math class. While most Hong Kong students use them, calculators were rare in Taiwan, Japan, and Korea. All four countries were in the top five spots.

CHANGING CURRICULUM AND TEACHERS

Why have students' skills and corresponding achievement levels gradually deteriorated? There are multiple factors to consider. Minor changes in textbooks and curriculum were almost automatic to coincide with specific advances in technology and the new federal mandates. The most notable piece of legislation has been the No Child Left Behind (NCLB) Act of 2001. Today, seven years later, many school systems are still struggling with their curriculum and teachers' academic credentials in an attempt to meet the NCLB standards. Many school systems are scrambling for answers or any new viable approach to show improvement. Recently in Memphis, a newspaper story about local high school math education got everyone's attention. Memphis City Schools (MCS) has acquired new college graduates to teach mathematics through the New York-based non-profit 'Teach for America' organization [Roberts, 9]. The program runs for two years and places motivated graduates in some of the most challenged schools in the nation, which MCS certainly qualifies. While math scores have improved at one local high school, the new 'teachers' there have combined majors in psychology, political science, cinema, and Spanish. It will be two years before results of the program can be accurately documented. One would think that a teacher's knowledge of subject matter coupled with teaching experience would be primary factors in measurement of student success. Since none of the participants in this instance have a major in mathematics, it leaves the author wondering how effective it will be.

As previously stated, changes in textbooks are inevitable with advances in technology. Most everyone believes that every successive textbook edition improves on the previous one. The quality of the textbook will certainly help determine how successful any learning process will be. Have textbooks over the years been systematically dumbed down? The president of The Textbook League and the editor of *The Textbook Letter* certainly believes so [Bennetta, 1]. He has written about this 'dumbing down' evolution a few times. This author has witnessed firsthand the documented decline of a mathematical solution procedure on the calculator explained for the student. Our electronic devices textbook, years ago in the first edition, systematically listed in numbered statements the procedural steps for the solution. The procedure involves a complex formula converted to a quadratic equation format and is then solved. Presently, in the eighth edition of the textbook, the solution consists of a colored pictorial of a calculator keypad punching sequence. There is no explanation of the mathematical solution process, just the sequence order of the calculator colored buttons. The actual process and solution sequence has been relegated to the appendix pages.

This is why, statistically, some students are behind the eight ball by the time they arrive at college. The 2003 National Center for Education Statistics reported that 23 percent and 32 percent of students in fourth and eighth

grade, respectively, scored below the basic acceptable level in mathematics [NCES, 7]. Our department has witnessed firsthand the math skills, or lack thereof, of some of our incoming freshman. Four years ago, the department started giving our 'Electronic Circuit Technology' classes a quiz consisting of ten word problems from the State of Illinois Eighth Grade Mathematics Competency Exam. The students are allowed pencil and paper, but no calculators. The questions require an eighth grade level of math skills. The average grade of all eight classes in the last four years is 69.4 percent.

PASSIVE ATTITUDES

Parents and the public do not expect excellence or even passable skills in something like sports competition without lots of practice and repetition. So why should we expect any less from an academic subject? Most educators understand that a negative public perception exists with math. How many times have we heard an adult state that math was not their favorite subject? It should not be a surprise when parents tell their kids that it's OK if they are not good at math. They should be telling the children to be better than they were. Parents need to get involved, stress adherence to studies, and know what is required for success in their child's coursework. Although it has not been statistically verified, it is rumored that approximately 35 percent of high school students in the country never do any homework. Looking at the range of test results from our incoming freshman, that estimate could be very accurate today. Referencing the TIMSS, 25 percent of students have Internet access, but only about 10 percent use it for any class work in math or science [4].

Unfortunately, teachers may also be part of this problem and not realize it. Many high school math teachers do not fully understand, or fail to communicate to their students, the specific level of expertise that is required in mathematics for engineering science or technology majors. They are basically unfamiliar with undergraduate curriculums. Colleges are acutely aware of this fact. Dr. Robert McCabe, president-emeritus of Miami-Dade Community College, states: "Nowhere in America is there a match between the requirements to graduate high school and the requirements to begin college work." Dr. Hunter Boylan, professor and director of the National Center for Developmental Education, Appalachian State University, North Carolina, states: "Only 43 percent of America's high school students complete a college preparatory curriculum while 65 percent go on to college. So 22 percent enter college without having taken the curriculum that would properly prepare them." [Hamilton, 3].

Following is a statement in a Times Op-Ed piece; "The broader problem is not just in schools but society as a whole: There's a tendency in U.S. intellectual circles to value the humanities but not the sciences. Anyone who doesn't nod sagely at the mention of Plato's cave is dismissed as barely civilized, while it's no blemish to be ignorant of statistics, probability and genetics. In 1957, the Soviet launching of Sputnik frightened America into substantially improving math and science education. I'm hoping that the loss of jobs in medicine and computers to India and elsewhere will again jolt us into bolstering our own teaching of math and science."[Kristof, 5]

CONCLUSION

We know that our education system is bent right now, but hopefully not totally broke. This author wishes he had all the answers and could magically correct everything. Our students need successive science and math building blocks that are well developed by high school graduation.

To take a portion of the preface from a 1936 textbook that puts it into perspective:

"Under the traditional plan of studying trigonometry, college algebra, analytical geometry, and calculus separately, a student can form no conception of the character and possibilities of modern mathematics, nor of the relations of its several branches as parts of a unified whole, until he has taken several successive courses. Nor can he, early enough, get the elementary working knowledge of mathematical analysis, including integral calculus, which is rapidly becoming indispensable for students of the natural and social sciences." [Griffin, 2]

Given all of this, perhaps the most difficult task that we, as a society, will have to face is realizing the hardest part will be the changing of attitudes in this country. Changed attitudes can cause some fantastic results. Otherwise, we will continue on a downhill slide of academic achievement.

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