The Fragmentation of the College Mathematics Curriculum

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Abstract

The purpose of this paper examines to what extent and asking reason the fragmentation of college mathematics have attained the present development in the course of looking at the history of mathematics education. (Contains 1 table) (7 references)

Key words: math education, fragmentation of college mathematics, history of mathematics, math reform, and new math

According to Davis (1989), the United States' pre-kindergarten through high school curriculum must be held responsible for some of the misconception and fragmentation observed in post-secondary algebra courses. He commented:

> From this perspective, these courses and topics have the following structure. The student is asked to perform some fragmentary piece of a ritual. The student sees no purpose or goal to this activity, other than extrinsic goals (such as pleasing the teacher) or competitive goals (such as doing it better than Joey does). Consequently the student sees no reason why the ritual is performed one way and not another. The theory underlying such courses seems to be: if the students spend enough time practicing dull, meaningless, incomprehensible little rituals, sooner or later something WONDERFUL will happen. I have never shared this optimism (Robert Davis, 1989, p. 117-118).

Because the students Davis observed saw no purpose in doing a task that was dull and meaningless, they became frustrated and developed a negative attitude toward mathematics. For example, the breakdown of high school mathematics into differently named courses signals to the student that the concepts taught in each subject are independent of each other, even though those concepts are part of the system of mathematics as a whole. Some students might see geometry as completely different as trigonometry because the courses have different names, despite the fact that some theories of trigonometry are covered in geometry. Even in a single course, topic names could become confusing and cause a student to regard discrete pieces of information as different theories in each topic, even though several topics might use the same theory. As Davis pointed out, breaking mathematics into so many pieces made it difficult for his students to reconstruct and comprehend the larger picture. As a result, the image of mathematics held by students was confusing and their attitudes poor. They thought that mathematics was a boring subject requiring no imagination and was detached from real life (Furinghetti and Somaglia, 1998).

To understand how and why the fragmentation of college mathematics reached the current form, one needs to look at the history of mathematics education to clarify its boundaries, content, and methods (Coxford and Jones, 1970, page 1). Beginning with Columbus's discovery of America and continuing through each successive wave of immigration, the effect of foreign influences upon mathematics was profound. Mathematicians from many countries came to North America with their own practical needs, religions, and intellectual curiosities, which led to a change in the exploration and development of mathematics (Coxford & Jones, 1970, page 13).

Mathematicians came from different countries to share their ideas, the mixture of which contributed to the structure of universities. Colleges founded prior to the Revolutionary War, such as Harvard (1601), William and Mary (1693), Yale (1710), Princeton (1746), Pennsylvania and Philadelphia (1766), and Dartmouth (1770) did not have extensive mathematics requirements or offerings at first. Arithmetic was made an entrance requirement at Yale in 1745, at Princeton in 1760, and at Harvard in 1807. Geometry was not required for entrance until after the Civil War. As late as 1726, the only mathematics taught at Yale was a bit of arithmetic and surveying in the senior year. In 1748, Yale required some mathematics in the second and third years. Calculus was taught as early as 1758 and might have included arithmetic, algebra, trigonometry, and surveying by 1776. Harvard required "the whole of arithmetic" in 1816, and it was the first university to require algebra in 1820 (Coxford & Jones, 1970, 19). The gradual integration of higher level arithmetic introduced new math by different names, which made each level seem separate from "the whole of arithmetic," a situation that was further aggravated by the varying terms used by mathematicians of different nationalities.

In addition to the confusion posed by language and terminology, mathematics was hindered by educators who viewed the processes of mathematics education as an opportunity for character building rather than the subject's intended application. The philosophy behind the curriculum was described thus by Phillip:

> The theory presumed the existence of a few discrete facilities in the mind, including memory imagination, observation, will and reasoning. It was believed by mental disciplinarians that the curriculum should include those topics that best developed such faculties of the mind. Mathematics was high on their list, because memorizing tables would develop the capacity of memory, constructing proofs would develop reasoning, and solving a lot of tedious exercises would develop the will (1993, p. 244).

Phillip suggested that educators were more concerned with the challenges posed by the large volume of mathematics topics than with students' understanding. Because mental disciplinarians had thought that mathematics exercised reasoning and memorization, they had no desire to change the way mathematics was taught. Most likely, it is this philosophy of teaching that kept many instructors from reforming the mathematics curriculum.

As early as 1875, educators said that the curriculum was not effective for teaching students. Various mathematics societies attempted to change the mathematics curriculum, beginning with the *American Journal of Mathematics*, continued by the *American Mathematical Society*, and later furthered by the *National Council of Teaching of Mathematics*. Today books are artistic and colorful, graphing and scientific calculators are omnipresent, and many learning aids such as tutorial software are available. Even so, the content is largely unchanged from the curriculum of the late 19th century for local, state, and federal education system in the United States (Herrera, 2001; Martinez, 1998; Phillip, 1993).

The Third International Mathematics and Science Study or Trends International Mathematics and Science Study (TIMSS) was used to track changes in achievement over time. Moreover, TIMSS was closely linked to the curricula of the participating countries, providing an indication of the degree to which students have learned concepts in mathematics they encountered in school. In 2003, some 46 countries and over a half million students participated in TIMSS at either the fourth- or eighth-grade level, or both.

This study's survey was taken every four years, from 1995 to 2003. The results of the study were especially significant because the TIMSS study was implemented during educational reform in the United States. In 1995, students who participated in TIMSS were still learning from the old United States textbooks, but by 1999 schooling methods and materials had changed. In 2003, students participating in TIMSS were educated by a reformed curriculum. Therefore, it was possible to observe the transformation of schools in the United States and detect whether educational reform could affect student's mathematic achievement (Mullis, Martin, Chrostowski, 2004). Table I indicates the mathematics averages for 4th and 8th grade students in the United States and the rest of the world (Internationally) from 1995 to 2003.

Table I
Difference in TIMSS Mathematics Average Scale Scores for 4th and 8th Grade Students in the United States and Internationally during 1995, 1999, and 2003

United States	1995	1999	2003	Difference (2003-1995)	*Difference (2003-1999)*
4th	518	n/a	518	0	*n/a*
8th	492	502	504	12	*2*
International					
4th	529	n/a	495	-34	*n/a*
8th	513	487	466	-81	*-21*

Source: Mullis et al., 2004; Medrich et al., 1992. International Association for the Evaluation of Education Achievement (IEA) and Trends in International Mathematics and Science Study (TIMSS), 1995, 1999, and 2003

The results of the TIMSS 2003 report indicated that United States' 4th grade mathematics average score was 518 and remained constant from 1995 to 2003; however, the 8th grade students' mathematics average scores increased over the three-year period.

Conversely, the International students' mathematics averages dropped from 513 in 1995 to 466 in 2003. The trends showed that United States' students' mathematics average scores were significantly better than the International students' during 1995, 1999, and 2003. States remained affluent, a technologically advanced nation that had an advantage in education.

The trends were used to analyze the mathematics average scale score of achievements and failures, to compare and contrast the United States' and International scores, and to make relevant decisions about the United States' students' curriculum and textbooks. This has allowed the educational system to evaluate and revise the teaching and learning methods as needed for the current scientific and technological world. These trends may have been influenced by the fact that the United the conscious use of multimedia in instruction may prove to be a benefit to students of mathematics in the United States.

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