Content vs. Pedagogy in Math Education: A Modern Day Dichotomy?

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"Sputnik Was Nothing: The calls for a crash program to defend our superpower status are even more urgent now" (*Gerstner, 2005)!* This headline from *Newsweek* magazine is dated November 29, 2005. Gerstner, former chairman of IBM and current chairman of the Teaching Commission, demands a reform in math and science education and suggests that Americans are on the "wrong end of the brain drain." Does this sound familiar? Appeals issued to defend our "superpower status" are not new to Americans. Such calls have come whenever our nation has appeared to be threatened. Educational reformers have used the theme of gloom and doom as the ultimate trump card to advocate a change in current educational policy. Arguably the most significant call came in the winter of 1957 after the Soviet launching of a small satellite named Sputnik into orbit. Bybee (1998) calls Sputnik a "historical turning point." Immediately following Sputnik, America found itself caught up in a wave of reform that I believe was one of the most important battles fought between two opposing forces in American education: Progressives and Essentialists. At the heart of this war, I will argue, is a debate between content and pedagogy.

It is a commonly held misconception that Sputnik singularly instigated mass educational reform in the United States. While it is true that rapid reform took place in the wake of Sputnik, the reality is that the reforms of the 1950s and 1960s were already in progress well before Sputnik (Bybee, 1998). To appreciate the reforms during this period one must understand the on-going struggle between "progressives" and "essentialists" and how the see-saw battle for power manifested itself in the decades prior to the 1950s. The progressive movement began during the late 19th century when John Dewey, a philosopher who objected to the manner in which schools taught students, began an experimental school in Chicago. Dewey argued that schools should consider the attitudes and interests of the child first and regarded the pedagogical

practice of rote memorization, a standard practice of American schools, abhorrent. Progressive became a label describing a way of thinking that opposed reliance of text books, memorization of facts, and an isolation of education from experience. Progressives tended to (and still do) favor learning that is experiential, interesting, motivating, and relevant (Ornstein, 2004). The Cardinal Principles of 1917 (sponsored by the NEA) secured power for Progressives after it was lost during WWI. Before long, progressive ideology began to evolve into new extremes that went further than developing pedagogy that made mathematics more child-centered- this generation of progressives sought to eliminate the teaching of advanced mathematics altogether.

Prior to Sputnik, progressives dominated the educational arena at both the national and local levels. During the first quarter of the century, few people saw a need to know mathematics beyond simple arithmetic. According to Raimi (2006), American icons like Edison, Whitney, Eastman, and Ford had little use for advanced math. Educators reflected this attitude too. Raimi wrote, "Progressive educational theorists who were leading the way in the democratization of the schools distrusted any teaching that did not fulfill a "felt need" of the student…"

One of the key persons responsible for advancing this perspective was William Kilpatrick. Kilpatrick was arguably one of the most influential persons in the shaping of education, especially math education, during the first quarter of the century. Kilpatrick was a protégé of Dewey while teaching at the Teacher's College (a progressive think tank) during the years of 1911 - 1938. Dewey once wrote that "progressive education and the work of Dr. Kilpatrick are virtually synonymous" (Klein, 2003). His text, *Foundations of Method,* became a standard book for education programs nationwide (Klein). Kilpatrick, who majored in mathematics as an undergraduate, taught over 35,000 teachers-to-be in 27 years. It may be surprising, then, to read Kilpatrick's views on mathematics education. Kilpatrick indirectly

influenced nearly an entire generation of youth by indoctrinating their teachers with the belief that algebra and geometry *should not be taught* at the secondary level (Klein). In fact, Kilpatrick wrote that mathematics "is harmful rather than helpful to the kind of thinking necessary to ordinary living" (Klein). Snedden, a contemporary of Kilpatrick's at the Teacher's College wrote that "Algebra … is nonfunctional and nearly valueless subject for 90% of all boys and 99% of all girls—and no changes in method or content will change that" (Klein). In 1915, the NEA invited Kilpatrick to chair a committee to study the problem of teaching mathematics in high school. Kilpatrick's report, entitled *The Problem of Mathematics in Secondary Education*, argued that nothing in mathematics is of any value unless its can be demonstrated. He further recommended mathematics education for only a select few students (Klein). The U.S. Commissioner of Education published Kilpatrick's report in 1920.

The mathematical community was justifiably outraged and responded with a report of its own. In 1920, the National Council of Teachers of Mathematics (NCTM) was founded to directly challenge the progressives' policies on math education. In 1923, The Mathematics Association of America (MAA) published *The Reorganization of Mathematics for Secondary Education (*also known as *The 1923 Report)* to argue against the progressive agenda for math education (Klein, 2003). The NCTM served as the primary outlet to disseminate the *1923 Report.* The 625 page document was a collection of work from mathematicians, math teachers, and administrators of secondary schools. The *1923 Report* surveyed secondary mathematics curriculum, examined how math teachers were trained in other countries, and even discussed the psychology of studying mathematics (Klein). Finally, in direct contradiction to Kilpatrick's report, the *1923 Report* justified the learning of mathematics in terms of both applications and its intrinsic value and argued that "algebra is important to every educated person" (Klein).

Due to the progressive climate in education during this time, Kilpatrick's report exuded more influence. Throughout the 1930s, progressives launched the Activities Movement (inspired by Kilpatrick's writings) which integrated all subject matter and opposed separate math and science instruction. Not surprisingly, learning one's multiplication tables were not considered legitimate activities (Klein, 2003). During the 1940s, schools began implementing the "Life-Adjustment Program" to meet the perceived needs of the 60% of students who were not gifted enough for college or for the skilled labor market (Klein). The result was a steady decline in the number of students who took math courses at the level of Algebra or higher. According to Klein's research, 56.9% of students from 1909-1910 took Algebra and 30.9% took Geometry. In 1948-1949, the numbers had dropped to 26.8% and 12.8%, respectively (Klein). In 1954-1955, the numbers were 24.8% and 11.4%, respectively (Klein).

The attitude aforementioned that mathematics was not necessary shifted when science and technology collided with the advent of "radar, cryptography, navigation, atomic energy, and other technological wonderments…" (Klein, 2003). Science and mathematics gained a level of prestige in the public's eye after the development of the atomic bomb. Sophisticated mathematics was now required to function in these disciplines. It seemed that, for a time, Americans would begin to value mathematics and science education. This was, unfortunately, short-lived. Progressives marched on. Meanwhile, critics began calling for a return to basics in mathematical literacy- the fundamental skills that were *essential* to know. Cuban comments, "Post WWII critics like Arthur Bestor saw American schools as flabby and unintellectual" (Mondale, 2004).

The disregard for the importance of mathematics education and training had a devastating impact on multiple generations of students. The result was a decline in the quality of students

who went on to be teachers (Raimi, 2006). Educators were, by and large, ill-equipped to teach mathematics beyond Algebra (Raimi). In general, teachers knew little about mathematics and were not expected to be "subject matter competent." According to Raimi, the average American schoolteacher in 1930 was from a two-year "Normal School", and "unless destined for high school teaching studied no mathematics whatever beyond what she had herself learned as a child …" (2006). To make matters worse, the same ignorant teachers were responsible for writing their own textbooks! (Raimi).

Colleges nationwide during the late 1940s and early 1950s began experiencing an epidemic of incoming freshmen who were mathematically ignorant. Colleges began forming their own committees to examine the problem and propose measures to bring about a favorable solution. In 1951, the University of Illinois formed a group of professors called the Committee on School Mathematics (Klein, 2003). Max Beberman headed this group. Beberman's committee was initially formed to measure what students knew as incoming freshman. Their responsibilities grew to listing key "competencies" a high school student intending to pursue scientific studies in college should know (Raimi, 2006). Soon, they began creating materials, testing the curriculum in their own experimental high school, and finally publishing their work in the form of textbooks. Numerous colleges and universities followed UI's example. The "New Math" era was born- a full six years before the launching of Sputnik.

Beberman marketed his work nationally and he became more and more popular. He was able to capitalize on the growing frustrations the public had with the educational establishment dominated by the progressives. The nation was showing signs that it was ready for reform in mathematics education. For the first time, mathematicians worked alongside with math educators to create curriculum. Together, they created materials that were mathematically

rigorous, consistent, and focused on basic skills. Essentialists stood poised, ready to snatch power from the progressives who found themselves on the retreat during the middle of the 1950s. The only thing reformers needed to instigate wide-spread, systemic change was a catalyst. The excuse for change came in October of 1957 in the form of a kerosene powered satellite named Sputnik.

According to Dickson (2004), "Sputnik appeared at a moment when America was anxious on several fronts. For starters, the bottom had fallen out of a seemingly indestructible economic boom. Stock prices, which had started to falter in the summer, had been dropping steadily in September 1957…A recession was in full swing. Personal and business income were both down for the year and unemployment was on the rise (Dickson)" Dickson follows with, "Add to that the appearance of Sputnik and it becomes clear why there was a sudden crisis of confidence in U.S. technology, values, politics and the military" (2004). Sputnik served as the excuse essentialists needed to implement their calls for change.

Americans, it seemed, had already lost ground technologically and scientifically to the Russians. The assumption was that "they [the Russians] were better educated" (Mondale, 2004). The solution? Fix the schools. Reformers tended to be essentialist in nature and had been preparing for nearly a decade. They stepped in with ready solutions. For the first time ever in the history of our country the federal government, in the form of Eisenhower's National Defense Education Act (1958), began giving schools money to bring about change. The federal government spent $100 million dollars annually on public education to implement the curriculum materials that universities nationwide had been developing.

The combination of national insecurity, a lack of confidence in public school math & science curriculum, and the federal government willing to funnel money to promote change led

to one of the qualities that distinguish Sputnik reforms from all others: the suddenness of change. The American response to Sputnik was swift and dizzying. This fact cannot be overstated. **"***Overnight*, the schools changed" (Mondale, 2004). The threat of America's demise proved to be a powerful and motivating force. Spring tells a story of a math teacher pointing a finger at him admonishing, "There's Ivan studying math and if *you* don't study math, *we're* going to lose to communism. I was forced out of history programs and into math and physics programs as a result of Sputnik" (Mondale).

Change came with intensity never-before seen in American education. The US government sought help from mathematicians to overhaul mathematics education. Mathematicians and other educational essentialists had ready answers in order to meet the threat posed by the Russian Space Program. Formulated at Yale University in 1958 under the leadership of math professor Ed Begle, the School of Mathematics Study Group (SMSG) became the primary beneficiary of funds from the government to implement change. The SMSG was charged with the responsibility of increasing mathematical skill in the US and quickly eclipsed the work Beberman's committee had begun. With nearly unlimited resources, Begle set out with a multi-pronged approach. His first task was to develop a team to create exemplary textbooks- free of the mathematical ignorance and errors that plagued textbooks for the past 50 years. Bybee (1998) writes, "The reformers themselves represented senior scholars from prestigious institutions such as the National Academy of Sciences (NAS), National Academy of Engineering (NAE), and American Mathematical Society (AMS). They had affiliations with Harvard, Massachusetts Institute of Technology, Stanford, University of Illinois, University of Maryland, and University of California."

According to Raimi (2006), school teachers were also included in the writing of materials in an attempt to keep the content classroom accessible. The SMSG gave permission to all commercial textbook companies to copy, plagiarize, and reproduce their materials. The second prong concerned itself with dealing with the mathematical ignorance rampant in the world of mathematics teachers. The SMSG established literally hundreds of institutes nationwide to train the nation's existing teachers in the content, pedagogy, and usage of the new texts (Raimi). By the end of the SMSG's tenure 12 years later, more than half of the nation's high school math teachers had attended at least one institute. Moreover, according to Raimi, the nation's elementary school teachers outnumbered secondary teachers 10 to 1.

The "New Math" exposed American students to a heavy emphasis on mathematical principles and resembled a highly abstract systematization of the discipline. For example, first graders were taught axiomatic set theory to serve as a foundation for mathematics that would come at the secondary level. Mastery of essential skills, facts, and concepts became a primary goal of educators during this time. Math classes, in general, became more advanced and rigorous. Courses were designed that targeted specific ability levels and population subgroups. Calculus and advanced physics courses were eventually introduced at the high school level-thought not as quickly as one would expect. According to David Stiles (2006), a long time teacher of mathematics in the Corona-Norco school district, 1980 was the first year calculus his students had the opportunity to take calculus. Stiles recalls, as a high school student in the early 1960s, that trigonometry/pre-calculus was the most advanced course a student could take in Garden Grove, CA. It seemed that America was back on track.

Despite the crisis and the high hopes that inaugurated the reforms of the Sputnik era, however, the New Math movement did not last. By the early 1970s, New Math faced the same

fate as the progressive reforms it replaced. Progressives leveled criticisms that New Math took an unbalanced approach to teaching mathematics- placing too much of an emphasis on abstract reasoning and basic skills, lacking any applications, and being too demanding for many of the nation's math teachers. Begle lamented as early as 1960 that in his committee's work on curriculum "we did not consider the pedagogy" (Kline, 1973). By 1964, Beberman foresaw "a generation of kids who can't do computational arithmetic" (Kline). He felt that much of what became New Math became too esoteric and lost site of the "back-to-basics" theme that served as the red carpet for New Math reforms. None of the mathematics programs written throughout the late 1950s and the 1960s were in place by the end of the 1970s. The pendulum of power had swung back to the progressives during the 1970s amid concerns that essentialist policies failed to serve the needs of special-education, female, and minority students. To outline the remaining history is beyond the scope of this paper. Suffice it to say that during the Reagan administration and the publication of *A Nation at Risk* in 1983, essentialists regained control.

Much of today's educational policy and rhetoric is clearly laced with essentialist ideology. For example, the *No Child Left Behind Act* demands that every classroom be equipped with a teacher who demonstrates subject matter competence. High-stakes testing, born out of a desire to achieve "excellence," provides teachers with few opportunities to provide a liberal arts education for their students. There is little room to explore the interest of students; the pressure is on to cover a set of standards. Stiff penalties result when schools do not achieve their targeted test scores.

Despite the obvious dominance of essentialism today, I believe that there still exists a fierce war between essentialists and progressives. In 1998, U.S. Education Secretary Richard Riley called for "an end to the math wars" (Klein, 2003). Klein argues that the wars fought

over mathematics education in the 1990s were "never more contentious" (2003). That is quite a claim given the climate between Kilpatrick and the MAA/NCTM in the 1920s.

Some may argue that the modern-day standards movement is further evidence of essentialism. I have heard it said by many colleagues that the standards movement may even be the most solid evidence of essentialism. I am not so sure. The organization responsible for instigating the standards-based movement, the NCTM, is now highly progressive in philosophy and committed to transferring progressive ideas to its constituents. The NCTM, claiming over 100 thousand members, has grown from its humble beginnings and is now the world's largest, most powerful, and influential mathematical organization. The *NCTM Standards* reiterate the general themes of progressive ideology by advocating a student-centered, discovery style of learning known today as constructivism. Perhaps most importantly, the NCTM has used its political influence in recent years to get approved textbooks that are highly progressive curricula. I recently read on a professor's syllabus, "*There is a strong push in the United States for educational reform. It seems that the dominant educational paradigm is the transfer of information from the teacher to the students. The new paradigm advocates that students be actively engaged in learning, constructing information into relevant meaning, not just receiving it"* (Davis, 2006). This is nothing new. The concerns of progressives today are the same as they always have been.

What is the world of math education to do? I propose, first and foremost, that the age-old war over content vs. pedagogy end. After more than 100 years, beginning with the Committee of 10 in 1893 (sponsored by the NEA, just like the Cardinal Principles of 1917), progressives and essentialists have fought toe-to-toe, making little long-term progress. It should be obvious to all that the present approach is clearly not working. When each group has

wielded the power to make curricular choices, imbalance invariably occurred to the detriment of our nation's students. Essentialists go to one extreme to correct the sins of progressives by overemphasizing the mastery of basic skills and memorizing a body of facts that should be *essential* for all students to know. Progressives go to the other extreme by avoiding at all costs anything associated with essentialism and focus only on that which is motivating, interesting, and relevant. Further, progressives maintain only that which students discover or "construct" is truly learned (Budd, 2005). Is there a solution? I believe that there is.

Consider the following anecdote. Several years ago, I attended a leadership training seminar. At one point during the day, I was paired with a male colleague and we were asked to clasp hands as if we were set to arm wrestle. When the facilitator said "go", our goal was to maximize the number of times we made our partner's hand touch the table during the specified time. The activity ended just as you can imagine. The two of us, bursting with male pride and testosterone levels befitting a frat house ended in a stalemate. Neither one of us were able to bring the other "over the top." Interestingly, every other pair in the room experienced the same fate- regardless whether they were male or female. The presenter restated our task. He then questioned our impulse to fight against each other. "What would the outcome be," he asked rhetorically, "if you worked together?" After pausing, he calmly restated the task. At "go" my partner and I *worked together rather than against each other* to maximize the total of points we could accumulate. My partner let me pull him to the table and I let him pull me to the table. After a few seconds we had generated point totals well beyond what we initially thought possible. We were *both* winners. I believe that there is a transferable principle to be applied here.

Why can't essentialists work *together* with progressives instead of against? Can we have an essentialist informed by progressive practices in mathematics education? I believe that John Dewey himself would support this request. Can we have content *and* pedagogy? Absolutely! I do not understand why this is a modern-day dichotomy. In my opinion, it is a contradiction to even ask the question of content or pedagogy. You must have *both!* Informed by research, field experience as a teacher, and personal experience as a student, I believe that the best results are found when you combine both. There is a growing body of research available for all to examine the most efficacious pedagogies. Our technology dependent society requires us to be mathematically literate for purposes of both being able to function and being able to create new technology. Deciding the "*what"* to teach can be answered by the essentialists. Teaching math is no longer a question of *what*, as it was during Kilpatrick's generation, but *how.* Progressives can answer this question in spades.

I believe that I am a member of a new class of teachers who do not see a conflict in balancing the best of essentialism and progressivism. It *is* possible to maintain that teachers teach specific content (essentialism) in a way that is meaningful, engaging, and relevant to students (progressivism). Further, I submit that taking a balanced approach is superior to focusing on one philosophy at the exclusion of the other. I look to my own experiences as a form of validation.

For the essentialists, my students' test scores have always been head-and-shoulders above my colleagues. For the progressives, the vast majority of my students (and administrators) have walked away from my class with a newfound appreciation of mathematics, problem-solving and a love for learning in general. I often employ a number of discovery-based, technology-based, direct, Socratic, cooperative, and inquiry based lessons in my

classrooms. I shamelessly use whatever I need to help my students develop the requisite basic skills *and understanding* that will enable them to be mathematically literate. I look for applications whenever possible, but I also strive to help students see mathematics as an art in and of itself. Once a student reaches this plateau, relevancy becomes a moot point. While applications have their place, so does pursuing mathematical knowledge for knowledge sake. The mathematician in me is hesitant to claim "proof by example." However, the same mathematician in me also sees no problem in starting with my example and carefully deriving a more general result. I believe that a balance of essentialism and progressivism is clearly the superior choice.

The launching of Sputnik made it clear to Americans that the system of mathematics and science education was woefully inadequate. Today, 50 years later, it seems as if we are still fighting over the same issue of content versus pedagogy. If American youth are to truly be competitive in a global market, the current math wars must end. What will be the next crisis be that motivates extensive and widespread change in educational policy? And, will there be sufficient time for us to recover? If the *Newsweek* article quoted in the opening is correct, we do not have much time.

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