Reticence to Change in Education

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Abstract

Seeley (2015), expresses the problem of effecting change in mathematics education as linked to innovation in pockets of wonderfulness occurring in isolation. Seeley continues:

> When great events happen in isolation from the larger system within which they operate, we fall short of what might be possible otherwise.… Articulation and collaboration are important tools for making *lasting systemic change*. When educators fail to take advantage of these tools, students … miss opportunities to connect mathematical ideas. [Emphasis added.] (p. 171)

Working toward lasting systemic change in mathematics education requires stamina and persistence as well as an understanding of the complex interaction between culture, schools, and curriculum. Research into the history of mathematics education reveals over one hundred years of cyclic changes in mathematical content and pedagogy continually bringing us back to where we began, rather like a river that is pushed out of its natural path eventually returns to where it began. Why does history continue to repeat itself in mathematics education? Why does change only come in small pockets and as a mathematics education community we cannot seem to support and sustain systemic change? Is it perhaps, like Nature itself, humans and the systems in which we operate simply resist change?

A Metaphor of Change

The complexity of an educational ecosystem is difficult to understand from outside the system. Consider the tranquility of watching fish swimming in an aquarium. At first glance, the aquarium may be thought of as a single simple system where one need only add water, a filtering system, and fish, and then hours of enjoyment for the owner ensue. Aquarium owners, however, understand that the complexity of a healthy aquarium requires careful thought about the quality of the water, types of fish, appropriate food, filtering systems, and lighting.

Once one makes a decision regarding the water type—saltwater or freshwater—water quality is a key factor to a healthy aquarium. Water must first be tested, treated, and then retested. Appropriate plants, coral or rocks, and other underwater furnishings are added. After a few days, while still monitoring the water, one may slowly add fish to the tank. The keeper of the aquarium must give careful thought to the collection of fish, as not all fish get along together. Certain fish will hover near the bottom to keep things clean, while others school together in spiral patterns all over the tank. Some fish must be purchased in pairs, yet others are solitary and prefer to have no one else like them in the aquarium. All fish must be slowly introduced to their new home; otherwise, they will suffer shock and die.

Each aquarium has a fish population it can manage. A limit exists for how many fish, coral, snails, and flora can be added before changes must occur. Overcrowding the water causes pollution beyond what a filter is able to clear, and continually adding new additives to the water will not correct the quality. Regular and consistent maintenance of the tank requires removing and replacing a quantity of water. However, if toxins build up for too long, no amount of filtering or water replacement can purify the tank so the fish can thrive. Fish must be removed, water siphoned, tank scrubbed, and the process restarted. Although viewers from the outside see only the aquarium's beauty, the keeper understands the vast complexity of the aquarium's ecosystem.

Just as different aquariums require varying amounts of effort, so too do different schools require varying levels of engagement to bring about change. The filtering system in a school can be thought of as its communication network, constantly assuring toxins are not building up. The larger the school, the more complex the need for creative communication options becomes. For example, a complex population—novice teachers, veteran teachers, administrators—all at different levels of education and experience, will not perceive digital communication equally. Thus, a simple e-mail request of "Come to my office to discuss this!" can create unwarranted panic for some, while others totally ignore the message. The diverse population has dissimilar mindsets and goals and not all will work well together. Just as in the aquarium, one must consider the population of the school when adding new hires. Will the Clownfish fit in with the Anemone? Will this Damselfish interact well with the Yellow Tang? Sometimes when one determines a new fish might be a bad fit for the aquarium, it is not added. Nonetheless, when a new fish is highly desirable, then fish perceived to react badly with the new one are often removed from the tank. Maintaining the aquarium is a complex endeavor.

A similar complexity exists with changes to the curriculum and pedagogy in schools. As in an aquarium, where one cannot change the fish without considering the environment, likewise, when one considers the complexity in education one cannot change what happens in elementary schools without considering what happens at other educational levels. Changing curriculum at one level causes ripples throughout the system. Although a specific change may make it easier for the teachers and/or administrators at one level, it may not be best for the students, or vice versa. The change has to be systemic and universal; the process should consider the needs of all levels, all students, and all teachers. Everyone in the system must be engaged in the change process. Research suggests that to truly change the way elementary students learn mathematics, for example, one must first change the way elementary teachers are taught mathematics at the university level (e.g. Association of Mathematics Teacher Educators, 2017; Conference Board of the Mathematical Sciences, 2001, 2012; Ma, 2010).

Reticence to Change

Evolution is a slow, arduous process because Nature is innately reticent to change. Mountains, rivers, streams, and even great canyons have remained in the same location for centuries. Their alterations have only occurred through Nature's extreme events—earth-moving forces in the form of melting glaciers, volcanoes, rushing rivers, and meteors. Sir Isaac Newton expressed this in his First Law: "*Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it*" (Newton, 1934/1952, p. 14). Other scientists, such as Max Planck and Albert Einstein, imagined less fixed notions in the realm of physics (Hayles, 1991), lending substance for a more chaotic state of the coming and continuance of the cosmos. History and research seem to indicate, however, that Human nature tends to avoid chaos and be more comfortable with Newton's Law of stasis.

People—and the systems they create—resist change, and most systems are not fond of chaos. People carve out comfortable niches for themselves and find contentment in familiarity and the status quo. Change, whether in location, occupation, social status, or political leadership, creates conflict inside comfort zones, and conflict often creates chaos. Systems, as well as organizations, experience this chaos with regularity as people move in and out and up and down, thus disrupting the flow of status quo. Nonetheless, disrupting the flow is necessary for growth in any system. Waldrop (1992) suggested "species evolve for better survival in a changing environment … complex systems are more spontaneous, more disorderly, more alive," than static objects and somehow have managed to find a niche at "the edge of chaos" where the components of the systems "never quite lock into place, and yet never quite dissolve into turbulence" (Waldrop, 1992, pp. 11–12). Organisms in systems at the *edge of chaos* do not indicate or even create the hopefulness they will be willing to change. Achieving *lasting systemic change* in people may require similar interactive forces basic to Newton's Laws of Motion.

Change Theories

Searching for mechanisms to achieve *lasting systemic change* in education leads researchers away from physical science toward biological science—psychology. Changing people is a markedly different process than changing the location of a hill, perhaps because people tend to have more to say about what happens to them. Should a highway department decide to move a hill to make a new road more conducive to travel, no concern is given to the will of the hill. Rather, with a few well-placed explosives, the hill has been moved and road construction begins. However, should a more willful organism, such as a school district, decide to restructure its curriculum or staff, a few well-placed explosives will not have the desired effect. Chaos will ensue and, undoubtedly, change will happen, but not in any controlled manner. Change within systems involving people requires careful study, intentional consistency, engagement in the process at all levels, and knowledgeable leadership.

The works of Whitehead, Piaget, and Bandura have contributed to theories of change and are all familiar to educators. Other change theorists, such as Lewin, Lippitt, Prochaska, and DiClemente, are perhaps more familiar to medical professionals. Each of these theorists added worthy knowledge to the field of change, often building on the work of one another. However, Bandura's work remains the most relevant if one seeks to create lasting systemic change. His cardinal defining properties of a genuine change stage theory include "qualitative transformations across stages, invariant sequence of change, and nonreversibility" (Bandura, 1997, p. 412), and describe the traits required for *lasting systemic change*.

Developing a Stance for Change

Research on change theories began to emerge shortly after the end of World War II. In the late 1940s, both Whitehead and Lewin published their views on how change should occur; however, their foci were quite different (Lewin, 1947; Whitehead, 1949). While Whitehead focused his views of change on the development of children, Lewin examined societal changes. Both views are crucial to how change occurs in education. Lewin's three step process for permanent change – unfreeze, move, and refreeze – sounds simplistic in nature, but because the process is forced change, it can cause considerable disruption to the system it is forced upon. For example, even something as innocent as rearranging the teachers in a building by grade instead of subject can be unwarranted change for the teachers. In the unfreezing step, Lewin advised that problems can arise in different cases--including the removal of prejudices, complacency, and self-righteousness--in order to "bring about deliberately an emotional stir-up" (p. 35). Regarding such cases, Lewin cautioned, "since any level is determined by a force field, permanency implies that the new force field is made relatively secure against change" (Lewin, 1947, p. 35).

While Lewin's view of change describes moving people like cars, Whitehead's view of change in individuals is organic and can only happen when individuals are ready. He wrote in his essay, *The Rhythm of Education*, "life is essentially periodic," (Whitehead, 1949, p. 17) and to create intellectual progress, teachers must be aware of the periodic stages of romance, precision, and generalization. In the romance stage, one lures or *hooks* individuals to initiate change. One creates interest in the romance phase for it is the *sine qua non* or essential part "for attention and apprehension," (p. 31). One must constantly bear in mind "the pupil's mind is a growing organism," (p. 30) and the "natural mode by which living organisms are excited towards suitable self-development is enjoyment," (p. 31). Whether the pupil is a young child, a teacher, or a concerned citizen, this principle applies. One must romance an individual to bring about an interest in change and then, once interest is properly aroused, the next stage must come soon, before the interest dies.

Whitehead reiterated each of these stages in his essay on *The Rhythmic Claims of Freedom and Discipline* (Whitehead, 1949) writing "when this stage of romance has been properly guided another craving grows," in reference to the stage of precision. The precision stage follows romance as the interest has grown to a point of a craving desire to know more, to have more, to explore deeper into the knowledge base that has been introduced. Just as in a relationship, however, the romancing must continue to keep the precision stage alive. The romancing, at this point, works to "discover in practice the exact balance between freedom and discipline which will give the greatest rate of progress," (p. 35). When proper balance is achieved, the individual will be ready to move on to the final stage of the rhythmic cycle.

Generalization is the stage in which individuals are effective at what they have been working on and are ready to begin to show what they can do. In teacher education, this might be considered first-year teachers or in medical fields first year physicians. With internships completed and the desire for chosen occupations in their hearts, they relapse "into the discursive adventures of the romantic stage with the advantage that this mind is now a disciplined regiment instead of a rabble" (Whitehead, 1949, p. 37).

Piaget approached his ideas about change from a biological perspective and believed change occurs through self-regulation as an individual's knowledge or schemata is forced to a state of disequilibrium by encountering contradicting information to their schemata (Bandura, 1997; Dimitriadis & Kamberelis, 2006). He claimed changes to one's schemata are actively constructed and adjusted in response to "external *perturbances*," (Dimitriadis & Kamberelis, 2006, p. 171) and then the schemata become reorganized with the concepts of assimilation, accommodation, disequilibrium, and equilibrium.

Assimilation differs from accommodation to the extent of whether it is the schema or the experience that requires adjustment. Fitting a new experience into an old schema is assimilation whereas making an old schema fit a new experience is accommodation. For example, a new teacher would experience assimilation upon entry into an established school district; on the other hand, an established school district would experience accommodation at a sudden change in leadership. Piaget's theory explains:

> Adaptation is typically motivated by the experience of disequilibrium, the uncomfortable sense that one's experience is at odds with one's capacity to understand and explain it. When individuals experience disequilibrium (for whatever reason), they engage in the dual processes of assimilation and accommodation until they reach a new state of equilibrium where they feel they have developed good (or good enough) naïve theories of experience and the world. (Dimitriadis & Kamberelis, 2006, p. 171)

These are not truly *stages* because they occur over and over again as an individual experiences new situations and must make adaptations or else remain in a state of disequilibrium.

Nearly ten years after their writings, an expanded version of change emerged as a fusion of Lewin's and Whitehead's theoretical claims. Lippitt, Watson, and Westley suggested a "five general phases of change process" (Lippitt, Watson, & Westley, 1958, p. 130). Their five phase process included (a) development of a need for change or *unfreezing*; (b) establishment of a change relationship; (c) working toward a change or *moving*; (d) generalization and stabilization of change or *freezing*; and, finally, (e) achieving a terminal relationship.

The key defining element of the change theory of Lippitt, et al. is that the person, organization, or system being changed must be first be convinced change is necessary. Development of a need for change includes not only problem awareness, but also a desire to both change and to seek help from other sources outside the defined system. The authors stressed, "Problem awareness is not automatically translated into a desire for change," (Lippitt, Watson, & Westley, 1958, p. 131), but feasibility for change and confidence that obstacles can be overcome are also key elements to reach the *desire* phase. Too often those in leadership believe they are solely responsible for the condition of their systems and try to keep everything in-house. One can see this as a reoccurring situation in systems of all sizes—families, classrooms, businesses, and government. The desire for change is the primary requisite before moving on to any other phases.

Prochaska and DiClemente spent over a decade trying to define a set of stages one must go through to escape addictive behaviors (DiClemente & Prochaska, 1982; Prochaska & DiClemente, 1982; Prochaska, DiClemente, & Norcross, 1992). Although addictive behaviors are not always the impetus for necessary change in systems, there are significant similarities. Their set of five stages include: (a) pre-contemplation, (b) contemplation, (c) preparation, (d) action, and (e) maintenance (Prochaska et al., 1992).

In the pre-contemplative stage, a person is satisfied with stasis and has no intention to change his behavior. It is not a case of not being able to see a solution, but rather a case of not being able to recognize the existence of a problem. Similar to the first phase that Lippit, et al. describe, to move from the pre-contemplation stage to the contemplation stage—when a person acknowledges a problem exists—often requires pressure and/or coercion from an outside source, such as a family member or close friend. Even at this point, an individual must decide whether or not a change is merited or worth the effort. A person can remain in the contemplation stage for months or even years before moving on to the next stage.

The third stage—and it is with hesitancy they are numbered—preparation is where one begins to form a plan for change. It is in this stage that one intends a definite action within a short time, and perhaps one even takes small steps to reduce the frequency of participation in the behavior. This stage must quickly lead to the action stage, or else the person reverts to an earlier stage. The action stage is one in which "individuals must modify their behavior, experiences, or environment to overcome their problems," (Prochaska, et al., 1992, p. 1104). This stage is not to be equated with change, but rather the acting stage of the process of change. Mistaking it for change often occurs; as a result, one never reaches the final stage of maintenance, but rather a relapse into an earlier stage. The maintenance stage is not evidence of a change's finality, but rather that one has reached a phase where the work to avoid relapse must begin. Since relapse to addiction is "the rule rather than the exception," (p. 1104) continued support is needed.

When Prochaska and DiClemente began their early studies, they believed their five stages were linear; however, after more than a decade of repeated studies, they came to the conclusion the stages were spiral in nature. Prochaska and DiClemnte also posited that within this spiral context, individuals could enter, leave, or reenter the stages at any point along the spiral and could even repeat the stages multiple times. The success of lasting change continued to depend, nonetheless, on appropriate interventions occurring at appropriate times during the change process. Because of the conclusion they reached, Bandura believed their change stages were not a set of stages at all. He based his criticism on the biological definition of stages, such as the one a larva experiences as it transforms from a caterpillar to a butterfly, stating true stages must be performed sequentially, and that no repeating was possible. Considering his example of the transformation of larva to butterfly, one would have difficulty arguing his position (Bandura, 1997).

According to Bandura (1997), efficacy beliefs affect each phase of personal change: the adoption of new behavior patterns, their generalized use under different circumstances, and their maintenance over time. Bandura asserts, "People's beliefs that they can motivate themselves and regulate their own behavior plays a crucial role in whether they even consider changing" (p. 279). Outcome expectation is the second component of Bandura's self-efficacy model for change. He defines efficacy beliefs as "a judgment of one's ability to organize and execute given types of performances" and "outcome expectation is a judgment of the likely consequence such performances will produce," (p. 21). When efficacy belief is paired with outcome expectation the results of change can more accurately be predicted for an individual or group of individuals in a systemic organization. Both efficacy beliefs and outcome expectations can show either negative or positive aspects, but "productive engagement" (p. 20) ensues only when both are positive.

In order to bring about lasting systemic change in mathematics education, one might need to consider aspects of several theories of change. The ways children learn, adults think, and schools are organized are all essential components when considering the complexity of change in education. Attempting to alter the manner in which teachers should deliver lessons without considering the children to which the lessons will be delivered is a fruitless effort. Failing to consider the teachers, while attempting reorganization of schools, produces chaotic levels of stress and dissatisfaction. Attempting to adopt new mathematics curricula for students, whether at the national, state, or local level, without considering the schools' abilities to support a new adoption can result in epic failure for all stakeholders.

Systemic Change in Mathematics Education

> The history of mathematical teaching in this country is yet to be written. It is necessary to pay some attention to this history in writing upon the theory; as the traditions of the elders have a great influence, partly good and partly injurious. If we find that a tradition in mathematical teaching arose from definite reasons still in force, we must be cautious about rejecting it as useless; but such are not all the methods which have been handed down. (Safford, 1888, p. 5)

It seems as though the history of mathematics education has been written on a Mobius strip – there is really only one side, but people keep seeing two. Nearly 130 years have passed since Safford penned the above passage, when the country was in the midst of what has been referred to as an educational revolution. Secondary schools were growing exponentially across the still young United States of America, and the concern over content taught in those schools was a great concern of universities. In 1892, in order to address inconsistencies in secondary school offerings and college entry requirements, the National Education Association appointed a Committee of Ten "tasked with developing a plan for the nationwide standardization" (Fiss, 2011, p. 1185), and the educational world has been seemingly unhappy ever since.

The committee was headed by the president of Harvard University, Charles W. Eliot, and consisted of four other prominent college presidents, a college professor, the US Commissioner of Education, and three secondary principals. To fulfill its goals, the committee "formulated eleven questions" (Briggs, 1931, p. 135) ranging from what ages students should begin formal studies of certain subjects to how much time should be allotted to study each subject. These eleven questions led to the formation of nine more committees of ten members—eighty-nine men and one woman—mostly gathered from the East Coast. Only forty-two of the committee members represented secondary schools and of those, only seventeen were from public schools.

One of the nine committees specifically focused on mathematics, and their report contains significant irony. Although there were no representatives from the lower schools, the key focus of their endeavors was on coursework for elementary education, such as concrete geometry and some elements of algebra (Briggs, 1931). The mathematics committee members were primarily from universities, with only one of the committee members trained in pure mathematics. The remainder of the members were focused on the fields of physical science and contended mathematics might be learned incidentally through those studies (Fiss, 2011).

Citing a monograph by Safford (1888) as a cornerstone, the committee decided both arithmetic and mathematics should be taught through application and investigation. Elementary students would learn by measuring their classroom or the playground and estimating weights of various objects, while secondary students would benefit from constructions, physics laboratory experimentation, and practical astronomy. Therefore, to the committee members, the primary benefit of the study of mathematics was not as a mental exercise alone, but rather as a useful tool to understand everyday objects (Fiss, 2011). They conclude:

> The method of teaching should be throughout objective, and such as to call into exercise the pupil's mental activity. The text-books should be subordinate to the living teacher. The illustrations and problems should, so far as possible, be drawn from familiar objects; and the scholar himself should be encouraged to devise as many as he can. So far as possible, rules should be derived inductively, instead of being stated dogmatically. On this system the rules will come at the end, rather than at the beginning, of a subject. (NEA, 1893, p. 105)

Whereas in 2017, the above conversation sounds quite normal and wonderful, at the end of the 1800's the mere suggestion of knowledge not being epistemic to teachers and textbooks neared heresy. In the letter of transmittal accompanying the report, Commissioner of Education Harris, remarked, "I consider this the most important educational document ever published in this country" (National Education Association of the United States, 1893, p. ii). This opinion, however, was not the favorable reaction to the report. Some educators had a considerable number of concerns, including the time-saving omission of key mathematical sequences necessary for understanding concepts. In this regard, the single most outspoken critic of the report from the Mathematics Conference was Superintendent Greenwood of Kansas City, Missouri, Public Schools. Greenwood wrote, "To the Committee of Ten, and to the Committee of Ninety [i.e. the subject conferences], I will say, that the only way a boy can learn arithmetic is to study arithmetic and not to mix it up with other things" (Fiss, 2011, p. 1193).

Global Changes

The following decades saw tumultuous times. The United States' involvement in World War I, the Wall Street Crash, the Great Depression, immigration, industrialization, and urbanization all had an immense effect on mathematics education and schools in general. These events and others brought on vast changes to both the quantity and quality of the schools' populations. Sustenance and survival occupied the minds of the populace, rather than assuring mathematics with its rigor was taught in the schools. Each major historical event seemed to be followed by concerns that the education students were receiving was either not enough or inappropriate for the times. The mid-century period saw the beginnings of the race for space, which triggered even more changes in mathematics education. However, not all of these changes pushed mathematics education forward.

During this same time period, Alfred North Whitehead, renowned mathematician-turned-philosopher, was writing and speaking on mathematics education reform extensively. In his essay, *The Mathematical Curriculum*, he warned, "Any fundamental change in the intellectual outlook of human society must necessarily be followed by an educational revolution" (Whitehead, 1949, p. 77). In agreement with the results from the Mathematics Committee, whether coincidental or not, Whitehead stressed that due to the changes "mathematics, if it is to be used in general education, must be subjected to a rigorous process of selection and adaptation" (p.79). He recognized current reform efforts in mathematical instruction and acknowledged "changing a well-established curriculum entrenched behind public examinations" (p. 79) was difficult to do in a short time. Whitehead was also convinced mathematical concepts did not exist in a vacuum, but that number, quantity, and space were all interconnected relational concepts. He strongly believed little knowledge could be gained by teaching children "disconnected ideas" and that teaching in such manner would lead to "mental dryrot" (p. 2).

This history of mathematics education is essential in understanding why change is challenging. As Klein argues, "the education wars of the past century are best understood as a protracted struggle between content and pedagogy" (Klein, 2003, p. 176), and those wars or struggles are continuing today. The above passages from Whitehead (1949) could have well been applied in 2010 to convince the public of the necessity of a Common Core Curriculum for mathematics. Concurrent with Whitehead, another mathematician, textbook author, and university professor, Brownell, wrote an article that would become a classic in mathematics education. Doubters in Brownell's era asked questions similar to those asked by parents, politicians, and some teachers today in response to the curricular changes they are being asked to make, including:

> • Are meanings really necessary in the learning of arithmetic?
>
> • Are not meanings of the kind now called for really too difficult for children to learn?
>
> • Does it not take an undue amount of time to teach meanings—so much that other more important aspects suffer?
>
> • Suppose that meanings are learned: do they actually function; are they really used; may they not interfere with effective thinking? (Brownell, 1947, p. 11)

A Nation at Risk: The Imperative for Educational Reform (U.S. National Commission on Excellence in Education, 1983) captured the nation's attention with the blatant statement in its first paragraph: "The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (Denning, 1983, p. 469). It is no wonder the effect of this report was considered to be the most humbling on the nation since the launch of Sputnik in 1957. After delving into all the findings and deficits in education, *A Nation at Risk* recommended five areas needing urgent improvement: (a) Content, (b) Standards and Expectations, (c) Time, (d) Teaching, and (e) Leadership and Fiscal Support (Denning). As one reads through the list of specific recommendations under each category, it is difficult to find argument with the tenets of such a great wish list—increased teacher pay, smaller class sizes, more secondary mathematics, rigorous textbook choices, commitment of the public. The question might be, however, what happened to all of these good intentions given the nation responded so strongly to the report?

In 1989, when the National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics*, its members were sharing the culmination of "three years of planning, writing, and consensus-building among the membership of NCTM and the broader mathematics, science, engineering, and education communities, the business community, parents, and school administrators" (NCTM & the Commission, 1991, p. 1). Key goals of the NCTM's released standards were to grant students "*mathematical power*…the ability to explore, conjecture, and reason logically; to solve nonroutine problems; to communicate about and through mathematics; and to connect ideas within mathematics and between mathematics and other intellectual activity" (p. 1). This *mathematical power* would lead to students' "development of personal self-confidence and a disposition to seek, evaluate, and use quantitative and spatial information in solving problems and in making decisions" (p. 1). It would bring about "perseverance, interest, curiosity, and inventiveness" (p. 1), or perhaps it would just result in teacher frustration.

Responding to its teachers, in 1991 NCTM released a publication to guide teachers on how to teach the 1989 standards, *Professional Standards for Teaching Mathematics* (NCTM & the Commission, 1991). This publication included worthwhile tasks to engage students, instructions on conducting student discourse, descriptions of a proper learning environment, and an overview of what mathematics teachers should do to help students develop the mathematical power the 1989 standards would provide. Over the next decade, NCTM continued to respond to the changing needs of students and teachers and the 2000 publication of *Principles and Standards for School Mathematics* (NCTM, 2000) remains a remarkable feat. But the ink was hardly dry before The No Child Left Behind Act of 2001 was released as Public Law 107-110 (Boehner, 2002).

The No Child Left Behind Act of 2001 soon became known as simply NCLB, a 670-page document full of promises, goals, and ultimatums. Its primary goal, listed at the top of the first page under the title, "to close the achievement gap with accountability, flexibility, and choice, so that no child is left behind" (p.1) is as desirable today as it was at the time of the law's incipience. However, whatever it takes to close that gap requires something educators, politicians, parents, corporations, taxpayers, students, and every stakeholder in education simply cannot uncover. When President George W. Bush signed the NCLB Act into law in January 2002, from a political viewpoint, it "represented a sweeping reauthorization of the Elementary and Secondary Education Act, which was originally enacted in 1965 as part of Lyndon Johnson's War on Poverty" and was the "cumulative result of a standards-and-testing movement that began with the release of the report *A Nation at Risk* by the Reagan administration in 1983" (Rudalevige, 2006). However, from a classroom educator's viewpoint, it quickly became a four-letter-word that made educators' lives miserable.

The bill's verbiage and its mandate that all states implement accountability systems so that schools and teachers are held accountable for the education of *all* students seemed like an insult to teachers and schools. Mathematics educators had worked hard to establish standards and also to make provisions for implementation in teachers' classrooms. Many states had used the NCTM standards to create their own state standards, and by following NCTM's leadership and guidelines, they had the resources available to use in the classrooms to meet those standards. Teachers work hard to educate all of their students. The fact that some children get left behind is multifaceted and not always an indication teachers need a new accountability system; certainly not a system that takes students away from educational opportunities by establishing more high-stakes testing.

One would find it extremely difficult to debate NCLB's initial goal "to close the achievement gap…" (Boehner, 2002, p. 1); however, as with many legislative mandates, there remains a disconnect between design, interpretation, implementation, and funding. Although NCLB "brought test-based accountability" (Dee, Jacob, Hoxby, & Ladd, 2010, p. 149) to schools across the nation, it also created additional per pupil spending for schools to provide more direct instruction and student support without providing adequate funding. As had his predecessors, President Barack Obama expressed his "strong commitment to academic standards as a fundamental element of his educational reform agenda" (Mathis, 2010, p. 1) for the nation's children, saying:

> Because economic progress and educational achievement go hand in hand, educating every American student to graduate prepared for college and success in a new work force is a national imperative. Meeting this challenge requires that state standards reflect a level of teaching and learning needed for students to graduate ready for success in college and careers. (Mathis, 2010, p. 1)

Some celebrated the release of the Common Core State Standards for Mathematics (CCSSM) (National Governors, 2010) while others boycotted it. Those who embraced the document shared their beliefs through writing and presentations (Bowman, 2015; Bowman & Conrady, 2014) because they saw it as a continuation of the goals for which mathematics educators and NCTM have worked so hard. Others, however, perhaps just weary from attending to yet another set of standards, set out to block its acceptance in their states. Regardless of which side of the CCSSM one supported, NCTM continued to support the nation's mathematics teachers by releasing a guide to aid the implementation of the CCSSM, *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014).

Principles to Actions names six guiding principles for school mathematics addressed in the guide: teaching and learning, access to equity, curriculum, tools and technology, assessment, and professionalism (p. 5). Additionally, it emphasizes and supports the CCSSM mathematical practices:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.

5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning. (NCTM, 2014, p. 8)

After one-hundred plus years in mathematics education, very little appears to have changed. How different are these practices from what the Committee of Ten called for in 1893? The call for sense-making in student learning continues to be a primary focus, as well as modeling and structure. Students continue to be encouraged to construct methods rather than follow supplied rules. While the tools have changed, the focus remains on the child and a call for his mental activity—a return to beginnings, over a century ago.

Breaking the Cycle

Perhaps *lasting systemic change* in mathematics education is difficult to attain because, like the ecosystem in the aquarium, everything is in a continual state of flux. The addition of each new piece of legislation, standardization, curriculum, or administration, causes a ripple effect, which in turn results in systemic disequilibrium. Finding themselves at the edge of chaos mathematics educators grasp for a bastion, something secure they can believe in – thus the cycle continues– back on the Mobius strip of the history of mathematics education. But it is time to break the cycle.

Bandura (1997) stressed that lasting systemic change requires stakeholder conviction and conviction can only come through communication. The one thing that has changed in mathematics education is the advent of convenient and instant communication. Rather than traveling to conferences, webinars are readily available for mathematics educators to collaborate and negotiate change. Social media interest groups abound for mathematics educators. In these groups educators post questions and challenge ideas related to curriculum. Instead of individual mandates from separate interest groups dictating the course of mathematics education, combined efforts are resulting in jointly published research. *The Mathematics Education of Teachers II* (Conference Board, 2012) and the *Standards for Preparing Teachers of Mathematics* (Association of Mathematics, 2017) are just two bold publications that offer significant pathways to lasting change. Individual mathematicians and mathematics educators, such as Bass and Ball (2014), have worked in partnership to research mathematical learning in the field. In their lengthy partnership, Bass and Ball discovered that when mathematicians and mathematics educators collaborate in research that mutual respect for each discipline results.

Collaboration is challenging, however, digital communication eliminates many of the challenges that have prevented collaborative change in mathematics education in the past. The efforts of current educational leaders, educators, and mathematicians offer hope and encouragement that through dissemination of their research that colleges and universities will follow in these first steps of collaboration for *lasting systemic change* for mathematics teacher education.

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