CHAPTER 1

The Education for Workforce Development Paradigm

Using the idea of a paradigm as a lens for viewing the purpose of education in the USA—a workforce development paradigm—helps make the complex social structure and the limits of policies, practice, and problem domains visible. The way in which the USA approaches STEAM and STEM education is presented here through a review of how leaders and practitioners within the educational community are actively organizing, funding, and training to address challenges of STEAM education knowledge and practices.

The histories of STEAM and STEM are linked, and it makes sense to discuss them together. STEAM is an acronym. It stands for Science, Technology, Engineering, Art, and Math. Some definitions of STEAM indicate that the A stands for art and design. Other definitions suggest that the A stands for architecture. In this book, we will use the definition of STEAM found in a congressional resolution of May 1, 2015, that distinguishes STEM from STEAM: The "innovative practices of art and design play an essential role in improving STEM education and education research," and this is the reason given for adding the A. In addition, "art and design provide real solutions for our everyday lives, distinguish United States products in a global marketplace, and create opportunity for economic growth" (H.R. Res 247 2015, pp. 1–2). Thanks to this resolution, STEAM education is part of the official vocabulary of the US Congress. The language in the congressional record provides educators, and policymakers, with the official rationale for funding education initiatives.

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In August of 2015, the Congressional Committee on Commerce, Science and Transportation submitted a report to accompany the STEM Education Act of 2015 (S. Rept. No. 114–115 2015). The Act added computer science to the definition of STEM, in addition to continuing the support of STEM education programs through the National Science Foundation (NSF). The report states that more support of STEM education is necessary to develop a STEM workforce for manufacturers, high-tech companies, and small businesses across all sectors that struggle to find workers with necessary skills and knowledge to fill in-demand STEM jobs (pp. 1–2). The STEM Education Act became law in October of 2015. Among other things, the Act provided funding for prospective teachers to apply for scholarships, and for the NSF to fund education research in informal learning settings.

Congressional resolutions and various committee reports are how policy advocates, business leaders, and legislators in the USA communicate their views, practices, and understandings of STEAM and STEM education. The previously mentioned documents and many others shape the priorities of government-funded education research along the lines of national priorities that include national security and maintaining global competitiveness in international commerce. Funding education for national priorities is not a new phenomenon or isolated to STEM learning. Early efforts in public education were designed to train children to be "useful citizens" (Rury 2005, p. 3). The primary concern, as stated in the STEM Education Act of 2015 report, is to improve on how the future workforce is prepared to fill "in-demand STEM jobs, including those related to computer science" (p. 2). Proponents of the need for this legislation cite the poor performance of US students on the Program for International Student Assessment (PISA) of 2012. According to the PISA report, American students were ranked as 20th in science and 27th in math among the 34 developed countries that were listed (OECD 2013). These outcomes are considered to be significant problems in the US educational system. The proponents of STEAM and STEM education initiatives link poor performance on international assessments to inadequate preparation for participation in the workforce. This link might not be as strong as proponents of STEAM and STEM learning make it out to be. However, this perception, when viewed through the lens of a paradigm, could be an indicator of an emerging crisis (the inability to solve particular problems in the current paradigm) in the education for workforce development paradigm.

Weak Links

Michael S. Teitelbaum's book, *Falling Behind: Boom, Bust & the Global Race for Scientific Talent* (2014), provides a very helpful overview and analysis of questions related to American competitiveness in the STEM disciplines and workforce demand. In his review of the research literature, Teitelbaum cites numerous government reports and independent research papers. He reveals that there are many stakeholders, such as large corporations and the technology sector, involved in promoting government initiatives in STEM education. Teitelbaum concludes that there is *no consensus* among researchers about the preparedness of the US workforce to meet the needs of national interests (Teitelbaum 2014, Chap. 5, Loc 3450 para. 3). His book provides a historical analysis of STEM workforce funding that he describes as "alarm-boom-bust" and reveals the "unstable nature" of government and privately funded initiatives in STEM education and research.

Teitelbaum offers some examples. Both the 1983 report *A Nation at Risk*, published by the US National Commission on Excellence in Education, and the report titled *Rising Above the Gathering Storm*, published by the Academy of Sciences (2007), raised alarms about mediocrity in education and a crisis in global economic competitiveness. The America COMPETES Act of 2007 is an example of "boom" funding, and the US federal government shutdown in 2013 is a case of a "bust" event that unexpectedly constrained discretionary education and research funding at the NSF and the National Institutes of Health (NIH).

In chapter after chapter, Teitelbaum points to the lack of empirical scientific data in government and blue-ribbon committee reports. His analysis and research challenge the certainty of general assertions regarding STEM labor shortages and educational failure. Teitelbaum asserts that despite the limitations of inconsistent federal funding cycles, misalignments in workforce development, and overstatement of workforce needs, the USA is still competitive and produces many students prepared for the STEM workforce. In short, he acknowledges that there are problems in STEM workforce preparation, but "*a real shortage of scientists and engineers is not one of them* [his emphasis]" (Teitelbaum 2014, Chap. 3, Loc 1879 para. 4).

Teitelbaum points to the work of researchers Lindsey Lowell and Hal Salzman, who analyzed the data that was used to support the alarmist *Rising Above the Gathering Storm*. They released their report in 2007

titled, *Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality and Workforce Demand*. In it, they conclude that the reason that the USA lags behind other countries is that the large number of students in the USA impacted by poverty drags down the US ranking in international assessments of science and math performance. According to their report, our best students rank well and with the best students in the world. Lowell and Salzman's report further suggests that we should be concerned about addressing the learning of students performing at the lowest levels if improving the international ranking of students is the primary issue. They point out that there is no evidence that improving student achievement in school will lead to improved national competitiveness.

This selective review reveals that the scientific and education research community, in dialogue with business and government, is responsible for *raising the alarms* and for delivering the *critique of the alarmists*. According to Kuhn, scientists' response to a "crisis" is to identify where the discrepancy is in the field. "The problem is labelled *[sic]* and set aside for a future generation with more developed tools" (Kuhn 2012, p. 84).

Accountability and Achievement

The previous discussion of the education for workforce development paradigm highlighted reports that are used to frame the debate about problems in education. The practices that currently dominate conversations about teaching and learning include measurement of accountability and achievement, standardizing curriculum, and improving the qualifications of teachers.

The No Child Left Behind legislation of 2001 (NCLB) is an education reform that was designed to increase teacher accountability to improve student achievement within the current paradigm. The reports and legislative documents previously cited are responses to the assertions by political leaders, policy analysts, and other experts that education in the USA is in crisis. Common concerns mentioned in the legislation have included the need for more teacher accountability and the need for higher standards (NCLB 2001). Unfortunately, the NCLB reform effort fell short of the stated goals. In 2016, the Obama administration admitted that its revision to NCLB mandates, known as Race to the Top fell short of having the desired impact on reaching underrepresented students in the STEM disciplines (US Government 2014).

Achievement gaps are disappointing to teachers, parents, administrators, and politicians. They are also frustrating, demoralizing, and depressing to students because they are the ones who are coming up short. The problem of student achievement gaps in science and mathematics is another significant concern pursued in the education for workforce development paradigm. The solutions to problems of student achievement have focused on providing more educational funding in the following areas: national curriculum, national curriculum standards, standardized testing, accountability measures, technology in the classroom, increased teacher qualifications, and mandated professional development for teachers. There is education research that confirms that spending more money has helped schools close the achievement gaps between students in poor communities and middle-class students. Baker (2012) provides an example. National educational funding initiatives have supported the participation of more underrepresented students (females and minorities) in the STEM disciplines (US Government 2014). Despite all the money, efforts, and improvements, gaps persist. There is some utility in defining gaps to motivate educational reform. Achievement gaps create a simple way of framing the differences in performance revealed by standardized testing. Policymakers justified distributing local and federal funding to schools with underserved populations or punishing schools that did not make adequate progress by referencing achievement gaps. When NCLB legislation linked the results of standardized testing to criteria for judging the effectiveness of teaching in schools, achievement gaps became a significant concern. Student achievement data was going to be used to determine whether schools were helping students; lack of progress would result in withdrawal of funding and closing or reorganizing failing schools. By "motivating" teachers and administrators with a threat, accountability legislation created the conditions for excessive testing.

Standards

The fourth definition in the Merriam-Webster's online dictionary for the word *standard* reads as follows: *something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality.* Standards work very well in manufacturing environments where processes and materials are controllable. The education for workforce development paradigm provides the framework for preparing students to

participate in work environments. Measuring student performance is not just desirable but necessary for determining whether or not students are achieving to expectations. It may be helpful to illustrate how standards come into being with an example from mathematics education.

According to its Web site, The National Council of Teachers of Mathematics (NCTM) is a global professional organization of teachers with 60,000 members in the USA and Canada and is the "foremost authority in mathematics education" (Directors 2016). This group is concerned with advocacy, research, professional development, teaching and learning standards, issues of access and equity, and practices. When the reauthorization of laws such as Elementary and Secondary Educational Act (ESEA) is under consideration, the NCTM will produce letters of support for targeted funding for initiatives, such as those related to STEM education, in the reauthorization of the law (Bash 2015). As the experts on mathematics instruction, the NCTM influences national standards in teaching and learning such as the Common Core State Standards for Mathematics (CCSSM). The Common Core State Standards initiative was brought about by the U.S. Department of Education's need to grant waivers in order to continue federal funding to states that were unable to meet NCLB performance standards. One of the priority concerns of the NCTM is bridging the gap between research and practice. The NCTM will organize conferences and appoint committees to develop and publish reports to raise awareness in the mathematics education community. One such report emphasizes the fact that teachers (practitioners) have trouble accessing research and making the generalized findings in the research relevant to their particular circumstances (Arbaugh 2010). In raising awareness about disconnects between new standards, curriculum, and practices that have left teachers and students confused, other stakeholders in the education community can provide their perspectives. For example, teachers' unions and concerned parents pushed back against school districts and state school boards around the country. They claim that the testing is being administered before teachers and students have had an opportunity to adjust to the new curriculum (Weingarten 2013). There is a significant gap between the people who make standards and the people who must meet them. Awareness-raising and collective action are needed to bring practices, standards, curriculum, and theory together.

Don't Reform, Perform!

Many educators will relate to STEAM and STEM education legislation and funding efforts as the latest in a series of workforce competitiveness reforms. They will use the tools they have always used and work on problems in the same ways they always have. We can expect the good and bad results of those efforts to be recognizable as attempts at refining existing ideas about teaching and learning and measuring achievement. I am afraid that the frustration that people experience with education reforms and policy is likely to continue. How could it be otherwise, if the same tools and the same ways of looking at problems continue to be used? A new way of creating change is needed.

Uncritical acceptance of what I have described as the education for workforce development paradigm will make it hard to embrace new ideas and create new practices in STEAM education. The school system works for some students and some teachers, and it does not work for far too many students and teachers. Everyone agrees that more creativity and innovation in schools is desirable; it is in the congressional record. In my experience, thinking of innovation and creativity as something that needs to fit into existing practices is the wrong approach. When innovation and creativity actually happen in an institution or a learning activity, a transformation occurs, everything changes. STEAM educators are calling current teaching practices into question as they create new interdisciplinary practices and ways of being in educational institutions. Their actions, projects, and new relationships are the critiques or the new performances that underscore our need to go beyond reform to achieve/create/realize the transformation of educational institutions that we are all hoping for.

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