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## INTRODUCTION

According to *The Economist* (2014), the United States ranks 14th in educational performance among developed countries in 2014, far behind the top five – South Korea, Japan, Singapore, Hong Kong, and Finland. This is an improvement from being 16th ranked in 2012, but a far cry from being ranked 1st two decades ago. Put simply, other countries have been investing and innovating while the United States has lagged in these areas.

More specifically, the US high school graduation rate ranks 21st, much lower than the top five – Portugal, Slovenia, Finland, Japan, and the United Kingdom. The United States is ranked 48th in quality of math and science education. Overall, the United States no longer leads education and innovation in science, technology, engineering, and math. For example, Europe and Asia-Pacific now produce two thirds of published research papers.

Thought leaders in the US educational system saw this coming. Reports from blue ribbon commissions included *A Nation at Risk* (National Commission, 1983) and *Before It's Too Late* (National Commission, 1999). More recently (National Academies, 2007), *Rising Above The Gathering Storm* outlined the issues and approaches to addressing them. This section of the book provides a range of perspectives on the central issues for both K-12 and university education.

Throughout the many debates on K-12 education, there was usually great confidence that the university system in the United States was in fine shape.

This system has benefited from strong leadership over the past half century, as briefly outlined later. However, the system has recently come to face significant challenges as discussed later in this introduction.

The pre–World War II 20th century provided a hotbed of research in physical sciences and mathematics. Physics and computing are of particular note. However, the modern research university, particularly in the United States, emerged following World War II. Vannevar Bush, a 20th-century leader in engineering and science, was instrumental in defining the vision.

Bush articulated the central principles in *Science: The Endless Frontier* (1945):

- The federal government shoulders the principal responsibility for the financial support of basic scientific research.
- Universities – rather than government laboratories, nonteaching research institutes, or private industry – are the primary institutions in which this government-funded research is undertaken.
- Although the federal budgetary process determines the total amount available to support research in various fields of science, most funds are allocated not according to commercial or political considerations but through an intensely competitive process of review conducted by independent scientific experts who judge the quality of proposals according to their scientific merits alone.

Perhaps not surprisingly, Bush’s home university, the Massachusetts Institute of Technology (MIT), was very successful in adopting these principles. James Killian, MIT president from 1949 to 1959, notes that “From MIT’s founding, the central mission had been to work with things and ideas that were immediately useful and in the public interest. This commitment was reinforced by the fact that many faculty members had during the war direct and personal experience in public services” (Killian, 1985, p. 399).

He reports that MIT’s relationship with the federal government reached new heights with World War II:

- MIT took on critical challenges, for example, the Sage missile defense system and the Whirlwind computing project.
- Faculty and alumni serving in important advisory roles in the federal government.
- Faculty, including two MIT presidents, served in senior executive positions, on leave from MIT.

As a consequence, MIT became and remains a national resource, perhaps the key player in “big science.” In the process, MIT was transformed into a university. This was facilitated by several factors (Killian, 1985):

- A single, unfragmented faculty in consort with one central administration.
- Close articulation of research and teaching, of basic science and applied science.
- Continuous spectrum of undergraduate and graduate studies.
- Mobility of ideas resulting from the high permeability of the boundaries of both departments and centers.
- The extensive interconnection of its buildings.

MIT, and a handful of other leading institutions such as the University of California at Berkeley, California Institute of Technology, University of Illinois, and Stanford University, led the way defining the nature and “rules of the game” for research universities. In the process, science and technology has become central to our economy. As Richard Levin, former president of Yale University, indicates, “Competitive advantage based on the innovative application of new scientific knowledge – this has been the key to American economic success for at least the past quarter century.” (p. 88). He asserts that the success of this system is evident: The United States accounts for 33% of all scientific publications, has won 60% of Nobel Prizes, and its universities account for 73% of papers cited in US patents (Levin, 2003).

However, it is not clear that this traditional model is sustainable. James Duderstadt (2000), former president of the University of Michigan, summarizes several areas of concern identified in a National Science Foundation study:

- Public support has eroded with continual decline throughout the 1990s.
- Limits on indirect costs have resulted in cost shifting.
- The focus on research funding has changed the role of the faculty.
- Increased specialization has changed the intellectual makeup of academia.

He argues that the real issue is a shifting paradigm for universities. National priorities have changed, although recent security concerns have moderated this trend. The disciplines have been deified, yielding a dominance of reductionism. This presents a challenge for interdisciplinary scholarship,

particularly in terms of valuing a diversity of approaches and more flexible visions of faculty career paths. At the same time, undergraduate education is receiving increased attention, as have cultural considerations that, he cautions, tend to encourage “belongers” rather than “doers.”

Ruminating on the roles of publicly supported research universities, Duderstadt suggests several possibilities for strategies that universities can pursue as a response to current challenges:

- Isolation: Stick with prestige and prosperity, for example, MIT, Caltech, Princeton, Chicago.
- Pathfinders: Participate in experiments creating possible futures for higher education.
- Alliances: Ally with other types of educational institutions.
- Core-in-Cloud Models: Elite education and basic research departments surrounded by broader array of entities.

Derek Bok, former president of Harvard University, addresses the future of universities in light of many recent trends (Bok, 2003). He is particularly concerned with the commercialization of the university in response to a plethora of “business opportunities” for universities. He notes “Increasingly, success in university administration came to mean being more resourceful than one’s competitors in finding funds to achieve new goals. Enterprising leaders seeking to improve their institution felt impelled to take full advantage of any legitimate opportunities that the commercial world had to offer” (p. 15). He argues that this increased focus on commercialization may jeopardize the focus on education and learning.

Bok recognizes that this shift is nevertheless taking place. He cautions, however, that universities typically face several challenges that can hinder entrepreneurial aspirations. Bok summarizes these challenges, “On three important counts, the environment in most research universities does not do enough to encourage the behaviors needed for the sake of the students, the society, and the well-being of the institution itself” (pp. 23–24).

- Efficiency: “University administrators do not have as strong incentives as most business executives to lower costs and achieve greater efficiency” (p. 24).
- Improvement: “A second important lesson universities can learn from business is the value of striving continuously to improve the quality of what they do” (p. 25).

- Incentives: “Left to itself, the contemporary research university does not contain sufficient incentives to elicit all the behaviors that society has a right to expect” (p. 28).

These seem like reasonable challenges, at least for businesses. However, Bok argues “Leading a university is also a much more uncertain and ambiguous enterprise than managing a company because the market for higher education lacks tangible measurable goals by which to measure success” (p. 30). Furthermore, he asserts “Presidents and deans are ultimately responsible for upholding basic academic values but they are exposed to strong conflicting pressures that make it hard for them to carry out this duty effectively” (p. 185).

We would expect that market forces would resolve these pressures. However, Bok reasons “Neither the profit motive nor the traditional methods of the research university guarantee that faculties will make a serious, sustained effort to improve their methods of instruction and enhance the quality of learning on their campuses” (p. 179). In other words, we cannot expect an organically based transformation of academia, despite financial and social forces for fundamental changes. There is a fundamental tension between what is naturally happening in research institutions (i.e., increased focus on the external viability of research), and the way in which this is being managed, or not managed, within the same universities. The lack of attention and process in the midst of this evolution could halt the progress and risk the outcomes of the changes.

Charles Vest, former president of MIT and president of the National Academy of Engineering, provides both retrospective and prospective views of academia (Vest, 2007). He reviews the last half century in terms of how federal support has shaped the education system. He considers how the private sector, via philanthropy has shaped academia. The impact of September 11, 2001 on the openness of the research enterprise is his third topic. Finally, Vest considers how the Internet will likely impact the higher education enterprise. Perhaps not surprisingly, his projections and the actual consequences have been profound.

The Great Recession of 2007–2009 accelerated the decrease of state support for public education. Between 1980 and 2011, state support decreased by 15–70%, depending on the state. As a result, tuitions and fees have soared at public institutions, funded by government-backed student loans, and leading to student debt exceeding all credit card debt. In parallel, costs of operations at universities have soared, with most of the increases coming from administrative costs rather than delivery costs, for example, faculty

salaries. Consequently, higher education has become the poster child for runaway costs, replacing healthcare that now seems much more controllable.

This has led to new prescriptions such as Christenson and Eyring (2011) who explore how universities can find innovative, less costly ways of performing their uniquely valuable functions and thereby save themselves from decline. The authors outline the history of Harvard University and how various aspects of academia were defined by Harvard leadership in response to issues and opportunities of the times. They explore the strategic choices and alternative ways in which traditional universities can change to ensure their ongoing economic vitality. They emphasize the need for universities to address key tradeoffs and make essential choices as they decide how to compete.

DeMillo (2011) addresses the challenges faced by “the Middle,” the 2,000 universities that are not part of the “Elite” – those with \$1 billion plus endowments – and also face stiff competition from for-profit online universities. Computer-based and online technologies, such as MOOCs, and new student-centric business models are discussed. The book culminates in 10 rules for 21st-century universities, expressed in terms of defining value and becoming an architect of how this value is delivered.

It is clear that a transformation of higher education will inevitably happen. While the elite schools may sustain their current business models, the vast majority of educational institutions will not. Creative destruction will be rampant in education. The transition will likely be quite painful, but the end result promises much better outcomes at much more reasonable costs.

## **OVERVIEW OF CONTRIBUTIONS**

As discussed earlier, in the last decades, the quality of K-12 education in the United States has fallen in worldwide rankings. The costs of tertiary education are growing at a higher rate than inflation and the gap between rich and poor students’ performances is widening. On a brighter side, technologies such as computer-based learning, and now, massive Internet courses can be parts of the solution. But nothing will replace good teachers. What is at stake is not only US competitiveness but also national security.

Craig R. Barrett, a former professor of engineering and CEO of Intel, identifies three keys to success in “K-12 Education Reform in the United States.” The three keys are quality of the teachers, high expectations, and competition for better performance in the delivery of knowledge. A strong advocate of competition in the world of education, he believes that charter schools are part of the solution, along with the option of public schools and

homeschooling. Students should be motivated to believe that what they learn is relevant to their future, and parents should be free to choose the system in which their children are educated. Their choice should be independent of their financial means, and supported by an annual allocation of public education funds that they should be free to spend elsewhere. Focusing on the quality of education, he argues that teachers can be helped but not replaced by intelligent use of technology in the classroom, and that they should first be experts in the field they teach, then in methods and practices of pedagogy. He also recommends worldwide benchmarking of tests and curricula. He concludes that these goals – and especially competition in the world of education – will be reached only with the political will and support of leaders and voters.

Deborah J. Stipek, former dean of the Stanford University School of Education, argues that we should “Secure America’s Economic Future By Investing in Young Children.” She emphasizes the economic value of early education and the need for investments in preschools. She argues that the benefits of these investments go well beyond their economic return (in a recent study, 18% for a program in Chicago), and that they bring a host of other social benefits. Among others, they reduce the need for special education, and lower the rates of teenage pregnancy and of incarceration. They improve future learning abilities by providing the neurological foundations of early development. Later in age, she argues that one effect of preschool education is to bring more stability in students’ lives and an opportunity for children from low-income families to catch up to some extent, with their wealthier peers. She concludes that such a long-term investment will take political courage, but will be critical in the future competitiveness of the country.

Linda Darling-Hammond, a professor of education at Stanford University, addresses “The Future of Teaching in the United States.” She focuses on the social disparities that the US education system creates and perpetuates. This is true not only among American students from different social classes, but also between US students and those from other countries of the OECD. To bridge that gap, she advocates a centralized, state-run system, with adequate, equitable resource allocation. The objective is to avoid the disparities created by different levels of local funding between poor and wealthy communities. She also emphasizes the importance of competitive selection, appropriate compensation and evaluation of teachers. In practice, she recommends continuing improvement of teachers’ education, a licensing system based on performance, regular and meaningful teachers’ evaluations, and career ladders that motivate them by offering opportunities for advancements.

Lawrence S. Bacow has had considerable experience in university management, at MIT, Tufts, and Harvard. He addresses “The Conundrum of Controlling College Costs,” deploring the rise of college and university

tutions beyond the rate of inflation and points to the systemic contradictions that have led to this situation. Students and parents demand more offerings and student services, and the competition for star teachers, at ever-increasing costs, is intense. At the same time, the decline of state support in the current economic climate contributes to the gap between costs and revenues. He sees an opportunity in the use of technologies and massive online teaching. But mostly, he argues that collaboration among academic institutions might be the only way to control these costs, and that this can be achieved, if needed by modification of the legal system, without collusion and breach of antitrust laws.

William J. Perry, a former Secretary of Defense and an emeritus professor of engineering, discusses “Military Education.” He describes the massive improvements that have taken place in military education since World War II. From a low point in morale at the end of the Vietnam war, he sees the rise of a new generation of leaders – commissioned and noncommissioned officers – educated in top institutions both civilian and military. He believes that this improvement in higher education among the leaders of the armed services has contributed to the strength of US military forces that have never been as well prepared for their mission. He points out in particular, the role of understanding cultures and languages in the type of conflicts in which the United States is engaged at this time and the benefits of training foreign officers in US military institutions. As an example of how to achieve a high level of knowledge without an increase of costs that the country cannot afford, he describes a computer-based tutoring system that has been helpful to the military. While this is not a new idea in itself, its actual, successful implementation shows the potential of this approach to basic education when there can be little direct contact between teachers and students.

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