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An Assessment of Education Quality beyond Dinner Table Discussions

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Abstract

News media often publish comparative studies that report U.S. student performance in a global context. The school quality concern seems so simplistic that anyone who had compulsory education can chime into the discussion. In this article, the condition of U.S. education is further disentangled across the boundary of K-12 and higher education. Core program features are examined to reveal profound factors behind student performance in mathematics and science. These findings are grounded on triangulation of the interrelated observations that are typically obscured from test score comparisons across nations.

Keywords: school quality, test score assessment

1. Introduction

Casual discussions concerning school quality happen every so often at American dinner tables (Brandburn, Hartel, Schwille, & Torney-Purta, 1991; Rotberg, 1990; 1991). This topic has drawn more public attention after President Obama's first major speech on education – In March of 2009, the President called for drastically improving K-12 student achievement to regain lost international standing (see Klein, 2009). Built on the score comparisons, this warning has reminded the public of the gloomy headline news that followed the historical report of "A Nation at Risk" in the early 1980s (National Commission on Excellence in Education, 1983).

Despite the mediocre labeling of public education, the Cold War did not leave the U.S. education system on shaky ground, particularly in the sector of higher education. Krist (1991) acclaimed that "the U.S. graduates the highest percentage in the world of 24-year-olds from a four-year college or university" (p. 119). As such, the United States was able to attract more foreign engineering students than any other country. Engineering as a major seems to be a good indicator because of its heavy reliance on mathematics and science training. Bracey (1991) observed, "When it comes to the world of engineering, we educate the world, and we keep the best and the brightest" (p. 114).

Although the nation's research and development (R&D) capacity is closely related to the support of higher education, no additional report has been produced by the federal government to rectify the reputation of U.S. as "a nation at no risk". Instead of giving due credit to the student pipeline prepared at the K-12 levels, the school system was constantly pressed by policy measures in the past, including the No Child Left Behind (NCLB) act under the George W. Bush administration. In an effort to renovate the school accountability system, President Obama has indicated a desire to link teachers' pay to student performance (Klein, 2009). As the pressure escalates beyond the casual talks, more research is needed to examine the condition of U.S. education in a broad context. In this article, education outcomes are compared across the boundary between K-12 and higher education. School curriculum is examined to identify profound factors behind student performance in mathematics and science. Since those core subjects are taught around the world, the comparative lens may help enrich our understanding of U.S. education in the global context.

2. Perceptual Differences Between K-12 and Higher Education

To a great extent, attention on education quality has been guided by economic concerns for Americans' wellbeing. According to a three-stage model theorized by economists (see Ozawa, 1992; Porter, 1990), the

primary stage of the economy is grounded on exploitation of natural resources. The secondary stage relies mainly upon capital investments such as manufacturing industries. At the tertiary stage of the 21st century, the U.S. economy is more dependent on human capital, i.e., the productivity of educated minds and healthy bodies of workers (Mortenson 2009; Voldere, Janssens, Onkelinx, & Sleuwaegen, 2006).

The K-12 levels have been perceived as a crucial stage of student growth in cognitive, affective, and physical domains (Torp & Sage, 1998). Nonetheless, it was the cognitive aspect of student score comparison that continuously attracted public attention on international education reports (Levy, 2009). "Ever since international comparisons of science and mathematics test scores began in the 1960s, Americans have believed the myth that U.S. students are outclassed by those in other nations" (Rotberg, 1991, p. 778).

Politicians often wish to champion educational reforms according to the crisis perception of K-12 education. In the Clinton era, voluntary national standards were promoted to regulate science and mathematics teaching (e.g., National Research Council, 1996). Under the George W. Bush administration, the NCLB legislation stirred the public attention on various state assessment programs (Finn & Meier, 2009). At his inauguration, President Obama told a crowd of two million that "Our schools fail too many, … We will transform our schools and colleges and universities to meet the demands of a new age" (see Colvin, 2009, p. 15). Although colleges and universities were included in that speech, the news media has rarely addressed the quality of U.S. higher education. In part, this was because no international test had been conducted to compare college student performance around the world.

Despite the lack of score indicators, U.S. higher education has drawn the talent of international students around the world – 37% of the terminal degrees from U.S. universities were awarded to foreign students (Cao, 2008). In fact, the best universities in China (Tsinghua and Peking) have surpassed UC Berkeley to have more alumni earn a Ph.D. from U.S. universities (Figure 1). Along with this international recognition, it has been acknowledged that higher education has played a vital role in enhancement of the domestic R&D effort within the states (Mortenson 2009).

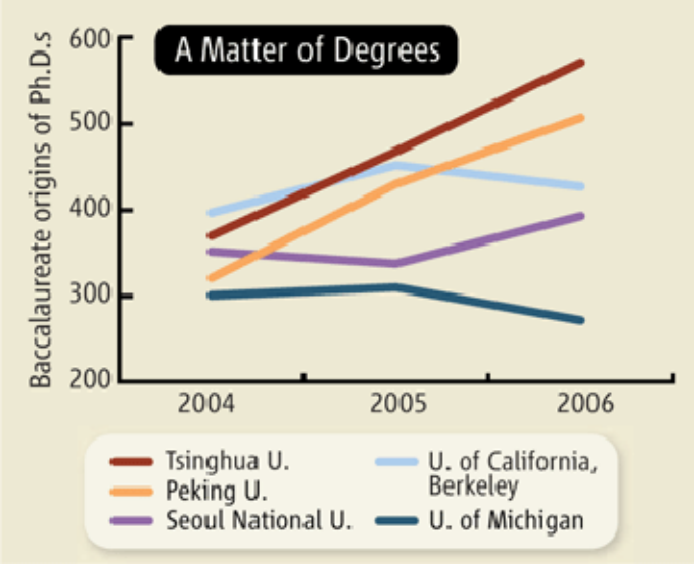

Figure 1. Major Student Pipelines of U.S. Ph.D. Graduates

If human resource development does not stop at the K-12 levels, then why don't we divert some attention to the quality indicators of higher education that have a more profound impact on the future economy? In this regard, Rotberg (1991) adduced the following education indicators behind the American competitiveness in the global economy:

1) How productive is the U.S. in basic and applied research fields? What does the marketplace say about the research opportunities in our institutions of higher learning?
2) What are our accomplishments in making major technological advances, as measured by patents and their application in products, in areas such as semiconductors, biotechnology, materials development, radiation imagery chemistry, information storage and retrieval, medical research, and pharmaceuticals?

3) Are the fields of science and engineering attracting high-achieving students? Is there a shortage of students or faculty members in these fields?

4) Does higher education give students who do not major in those fields some understanding of key scientific issues and methods?

5) Are we maintaining the technical expertise of the workforce? (p. 300)

Although the quality of U.S. education does not appear so dreadful on these five indicators (e.g., Ansary, 2008; Bradburn, Haertel, Schwille, & Torney-Purta, 1991; Ravitch, 2007), the news media prefer to highlight the negative stories at the K-12 levels (Rotberg, 2005). A characteristic of U.S. education is local control, and school district boundaries are aligned with residential neighborhoods. Thus, the perception of school quality is directly linked to home values within a local community. Similar to a nonchalant chat about weather, it is easy to discuss the familiar topic of school quality in daily conversations.

Whereas most adults in the U.S. have experienced compulsory education, higher education is not free for everyone, nor does it exist in every community. Thus, the quality of higher education seems less relevant to local residents, particularly for those who have no child in college. To expand the horizon beyond a local setting, comparative studies need to articulate higher education as an inseparable component of human resource development.

3. The Division Between Secondary and Higher Education

In comparison to countries in East Asia, the U.S. seems to have more flexible course offerings across the board for K-12 and higher education. For instance, China has secondary education tied to an annual college entrance examination. A dividing line is drawn by the examination to differentiate the curriculum boundary between secondary and higher education. Schools are primarily judged by the number of graduates who can enter well-respected universities. Although calculus courses are offered in many high schools in the U.S., few Chinese schools offer this learning opportunity because of its irrelevance to the college entrance examination.

The inflexible Chinese curriculum inevitably undermines effective teaching practice. According to Vygotsky (1978), teaching activities should be designed within "the zone of proximal development" (ZPD), and the content should be positioned slightly ahead of student progress. Since no Chinese teacher is encouraged to cover the content beyond the scope of the college entrance examination, advanced students are likely to have their academic progress blocked by the rigid curriculum boundary.

Test pressure has not only denied individual needs in secondary school, but has also worn out student learning interests in higher education. When the pressure is lifted after ~~the~~ college entry, some students lose their motivation for higher education, and became addicted to Internet games (Deng & Xuan, 2009). As a consequence, the Chinese college dropout rate has surfaced as a severe problem.

Although the SAT and ACT tests in the U.S. take much preparation time, these aptitude tests are not aligned with any specific school curricula. College performance is the target criterion for these aptitude tests to predict. Besides preparing for the SAT or ACT, high school students can choose to take courses for advanced placement (AP) or an international baccalaureate program to earn college credits. Moreover, concurrent enrollment can be arranged to allow enrollment of high school students in college courses. By blurring the boundary between secondary and higher education, high school students are encouraged to dig into the rich mine of knowledge from college curricula.

In summary, as Chinese students are confined by the boundary of the college entrance examination, the division between secondary and higher curricula is not as clear in the U.S. This flexibility has not only helped U.S. students win the tertiary race at the beginning, but also shortened their journey to the subject frontier in higher education. Apparently, this strength of U.S. education was not fully reflected by international comparison of test scores below the college level (Beaton et al., 1996). Therefore, although U.S. students do not outperform their peers from East Asia on international tests, many countries around the world still value college degrees from the U.S. higher education system, particularly in the areas of mathematics and science.

4. The Condition of Science and Mathematics Education

Besides identifying the strengths of the U.S. system, the weakness is visible in the area of teacher preparation. For instance, Su, Su, and Goldstein (1994) observed K-12 science teaching in the U.S. from Chinese perspectives, and reported that "Several Chinese scholars witnessed American teachers and students carrying out the wrong scientific experiments and calculations with great enthusiasm" (p. 260).

Mathematics and science faculty usually fulfill the mission of preparing educators in those core disciplines, but Hestenes (1987) noted that "Pedagogical theory is generally held in low esteem by university scientists" (p. 440). As a consequence, not all professors are willing to switch research focus to education because "just doing teaching in a research oriented university is not enough" (Fuller et al., 1998, p. 153).

The priority of a subject department typically places scientific research first, followed by the education of Ph.D. students, then Masters students, upper-level undergraduate majors and courses, introductory courses for majors, introductory courses for subject-related professionals, and finally the lowest of the low and often entirely absent, science/mathematics for non-specialists (Burnside, 2002). Redish and Steinberg (1999) observed that "Many physics faculty come away from teaching introductory physics deeply dismayed with how little the majority of their students have learned" (p. 24).

To improve this situation, Bruce Alberts (1994), the former President of the National Academy of Science, believed that professors in the subject areas should be educated away from arrogance toward educational research, and make a concerted effort to examine and resolve deeply ingrained misconceptions that are crucial to mathematics and science instruction. Moreover, university faculty should treat science and mathematics teaching as an inquiry-based academic discipline. Without a professional commitment to streamline knowledge accumulation, widespread teaching and learning issues often need repeated discoveries of similar solutions through trial-and-error methods in a disorganized manner. Similar to the relationship between *R&D* and *customer service* divisions in industry, college scientists or mathematicians should collaborate with educators for ongoing improvement of school quality in the core subject domains.

5. Time Gap in the Global Context

In addition to support for teacher education, it seems pertinent to compare school time designated for teaching. Some researchers have already used this unambiguous indicator for international comparison (Zhao, 2009). Wray (1999) pointed out,

> The American school year runs between 175 and 180 school days, and school day approximately consists of a nine-to-three weekday schedule. The Japanese Ministry of Education requires a 210-day school year, but local school boards are free to increase the number of days. (p. 4)

Stewart (2009) summarized that "The Chinese school year is a full month longer at the secondary level than American schools" (p. 95). Spread out over the K-12 grades, the shorter school year would make U.S. students lose more than one year of actual instruction in comparison to their peers from East Asian countries. Without enough time to learn the core subjects, American students appear to have involved themselves in an unfair competition against their peers in East Asia.

Nonetheless, education is a complex endeavor, and the investigation should be extended beyond the K-12 boundary. If the time gap exists within the K-12 school setting, similar issues could have impacted student learning in higher education. In the United States, the number of school days is comparable in higher education. Chinese education stakeholders have also attempted to maintain enough school days in higher education, including limiting the total summer and winter vacation period to a maximum of 85 days (Sun, 2010). Despite the similar time gap at the secondary and tertiary education levels, the outcome has appeared differently – Schools at the K-12 level endure pressure from international comparisons of the core test scores, while colleges in the U.S. maintain an excellent reputation around the world.

As a confounding variable, perhaps the time allocation has been outweighed by the instructional design. Su, Goldstein, and Su (1995) reported, **"**In comparison to the highly uniform classrooms and heavy emphases on basic theories and skills in Chinese science education, the American classes with their emphases on students' interests and individuality were very refreshing for Chinese visiting scholars" (p. 375-376). The individualized instruction also hinges on professional support from school counselors. Counselors handle the advisory services during the course break or after school. Since there is no counselor position in Chinese high schools, the advisement might have taken the extra class time, rendering the time comparison less accurate. The system difference could be deeply rooted in the education philosophy and test pressure. "In fact, in Chinese schools, developing individuality is considered as undesirable, independent thinking is not encouraged, and creativity is often stifled by the pressure to conform to common standards and performances" (Su, Goldstein, & Su, 1995, p. 384). Again, the test pressure might have led to an ineffective use of the additional school time in China, confining the instruction within digging the delimited mine of knowledge below higher education.

In summary, international testing does not fully consider flexibility in U.S. curricula, nor do the U.S. national goals address quality of postsecondary education (Krist, 1991). In-depth observations presented in this article

clearly urge a careful consideration of confounding variables behind the international comparisons. Whereas the gloomy picture of K-12 education could result from the score comparisons between U.S. and other countries in East Asia (Beaton et al., 1996), higher education did not share the same concern. According to Levy (2009), "in 2007, more than a third of all research doctorates were awarded to foreigners, and the proportion is far higher in the hard sciences" (p. A19). Effectiveness of teaching not only depends on the number of school days, but also hinges on the teaching emphasis that leads to a rich or poor mining of the human knowledge base at the boundary between secondary and higher education.

As Frank Richtmyer (1933), a founder of the American Physics Society (APS), pointed out, "That a knowledge of subject matter, however thorough that knowledge may be, is not of itself an entirely adequate preparation for teaching is at once recognized from the fact that there are many excellent scholars who are poor [college] teachers" (p. 1). Therefore, to translate the strength of the R&D power to teaching effectiveness in the U.S., college scientists or mathematicians should collaborate with educators for ongoing improvement of school quality in the core subject domains.

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