Blueprint for the Future: Framing the Issues of Women in Science in a Global Context: Summary of a Workshop (2012)

DETAILS

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APPENDIX E-3

Institutional and Cultural Parameters Affecting Women's Participation in the Fields of Chemistry, Mathematics, Statistics, and Computer Science around the World

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How women enter higher education, attain degrees, and work in chemistry, mathematics, statistics, and computer science is essentially regulated by the different cultures within their national societies. These express social, economic, and political values about the role of women in society, and shape the values of academic institutions. The latter are sometimes contradictory and burdened with a historical legacy inimical to the full participation of women in science. At the same time, an increasing international consensus about the practice of science tends to be much more supportive of women training and working in these fields.

What follows is a brief analysis of the multiple cultural and institutional factors affecting women's participation in science and mathematics around the world. Increasingly the major international institution for participation in science is the research university. Its origins are mixed, but the most emulated form developed in the United States after World War II. That this form flourished there is an accident of history. In 1945, few other countries were able to pour national resources into higher education after economies, infrastructure, and millions of citizens were destroyed by the war. The development of research universities was a deliberate result of federal policy and in tandem with the increase of national and private laboratories. After 1957, when the Soviets launched Sputnik, federal funds poured into universities, expanding facilities for big science, and increasing the number of doctoral-granting programs and graduate students (Geiger 2009). Undergraduate enrollment expanded from 1,494,203 in 1940 to 16,386,738 in 2008 (Chronicle of Higher Education [CHE] 1974; CHE Almanac, 2010). The research university or a similar form has a monopoly on doctoral conferral, and a historical legacy of exclusivity, internal stratification, and competition among academic fields. It transmits both academic and social values to students and sustains them in successive generations of scientists.

For modern research universities to successfully sustain their functions and the growing participation of women there are several preconditions. Historically, the most significant is the accumulation of wealth within a society sufficient for the development and support of cultural and educational institutions. The universities of Paris and Bologna, the better known European antecedents of the modern university, originated during the middle ages when the development of trade and production created sufficient wealth able to support centers of learning. Initially organized by the Roman Catholic Church to train priests, these universities later trained men for

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the professions of law and medicine. Although legally independent, universities existed by charter conferred by the monarch, and were valuable in staffing royal administration and developing the modern state. In many respects, early European universities had much in common with religious schools and academies in the Moslem and Asian worlds. In later centuries, however, the latter parted ways with how science and technology developed and the gradual democratization of access to secondary education in the West (Perkins 1991). A second precondition for the modern research university, therefore, is a well-functioning primary and secondary educational system to prepare students for university education. Intrinsically, this system of education should be largely secular and supportive of national and international norms of scientific inquiry and with a political system upholding both.

Closely associated with the creation of the modern research university is the growth of disciplinary and professional associations. Although not directly a precondition, they contribute to the organization of knowledge in a form in which standards of research are sustained and central concepts of each field are transmitted along with a discrete set of behaviors that set boundaries among the different fields. The fields and their professions are defined by the German sociologist Stichweh as "forms of social institutionalization… of processes of cognitive differentiation in science" (Stichweh 1994). As Tony Becher has put it so well in his *Academic Tribes and Territories,* this results in the creation of a scientific community with mutually comprehensible communications and a subject-specific language which defines the group and separates it from other knowledge-based groups (2004). This enables the growth of theoretical knowledge represented in textbooks characterized by: a.) codification, acceptance by consent, teachability; b.) a set of research methods and paradigmatic problem solutions; c.) a discipline-specific career pattern; d.) institutionalized socialization processes which serve to select and educate candidates according to the prevailing paradigms (Stichweh 1994).

Disciplinary membership became part of an international culture, which, as it developed, established that science is something men do, not women. While this is changing—and in some countries, changing rapidly—disciplinary organizations support the cultural framework for informal male networks, which continue to exclude women from access to higher education and professional employment.

By itself, the research university is a highly differentiated environment both apart from and reproducing the norms of society at large (Marginson 2010; Jaschik 2011). Today in the West, its values still bear traces of the period when the very small number of academics in universities were an elite, separated from the rest of society by the nature of intellectual work, who were curators of esoteric knowledge and recognized as members of an independent legal entity. Social and economic privileges accompanied this unique legal status, e.g., the two votes of each professor in German national elections until the Nazi period. One should remember that in any society prior to the modern period, academics were usually priests, thought to have a special relationship with god; indeed one can think of modern examples in which senior male professors tend to confuse themselves with god.

Along with a special status, the university and its faculty carry a particular responsibility as public actors. In the pre-modern period, this included preserving and transmitting knowledge and serving as expert advisors in largely illiterate societies. Today, this role is far more visible as academics advance knowledge through research and transmit it through teaching, publication, and service as experts, faintly echoing their historic role. All of these aspects of the present research university impinge on the participation of women in chemistry, mathematics, statistics, and computer science. Women are newcomers to a historically developed community, not yet

necessarily members of the elite club. Their presence in universities brings conflicts among different values: the role of women in society, disciplinary expectations, and those of the university.

Documenting how these cultural and institutional values affect women's participation today in the various regions of the world and in a limited number of countries illustrative of regional trends follows a uniform analysis. The first part of the analysis is historical, examining how the structure of the Western university developed together with science and technology. Second, it charts the role of Western science in imperial domination of the non-European world, and how universities were created in some parts of the world as instruments of political and ideological control (Vlahakis 2006).

For example, the conquest of what is now Latin America and the Caribbean by Spain and Portugal led to the Jesuits' creation of educational institutions in the early 1500s. These educated local elites promulgated Christian thought and Luzo-Hispanic world views to the detriment of indigenous knowledge. Today much elementary and secondary schooling is still run by the Jesuits and other Christian orders. Universities no longer follow the imperial model, but inescapably reflect an inherited cultural system largely unsupportive of independent roles for women (Europa Publications 2010). While increasing numbers of universities are becoming modern research universities, scientific research facilities lag and the entire region only produces 2.5 percent of the world's doctoral scientists (Koiller 2007). As part of this discussion, attention is paid to when chemistry, mathematics, statistics, and computer science developed as modern university subjects.

This example suggests how historical legacies affect the current situation, including the number and types of higher education institutions and the number and percentage of college age cohort enrollment. This is significant in order to understand why women in many countries are far less than half of tertiary enrollment. For example, India only enrolls 10 percent of this cohort, so it is not so surprising that women proportionately are underrepresented at Indian universities (Altbach 2010). This low percentage is offset by the size of India's overall population and its over hundred-year-old tradition of training doctoral scientists at European and American universities.

Following this is an exclusive focus on women in which girls' participation in secondary education and the extent to which science and mathematics are included in the curriculum. This has a direct bearing on when and in what numbers women were admitted to degree programs in chemistry, mathematics, statistics, and very recently, computer science. Most of this discussion is about the 20th and 21st centuries. Women's attainment of advanced degrees and subsequent professional employment also reflects the extent of their participation in the disciplinary associations.

The goal of this analysis is to illuminate the current situation of women in the four fields and lay the groundwork for later detailed analysis.

REFERENCES

Altbach, P.G. 2010. India's open door to foreign universities: less than meets the eye. *International Higher Education* 60:16-18.

Becher, T., and P. Trowler. 2001. *Academic Tribes and Territories: Intellectual Enquiry and the Culture of Disciplines*. Buckingham and Philadelphia: Society for Research into Higher Education and Open University Press.

Chronicle of Higher Education (CHE). 1974. Fact-File: A Century of Growth for U.S. Colleges. CHE: 1.

CHE. 2010. Almanac: Undergraduate Enrollments by Type of College. Online. Available at http://chronicle.com/article/Graphic-Enrollment-Levels/124068/. Accessed March 26, 2011.

Cole, J.R., and S. Cole. 1973. *Social Stratification in Science*. Chicago and London: University of Chicago Press.

Europa Publications Limited. 2010. *South America, Central America, and the Caribbean*. London: Routledge.

Geiger, R.L. 2009. *Research and Relevant Knowledge: American Research Universities.* New Brunswick and London: Transaction Publishers.

Jaschik, S. 2011. How Asian are Asian universities? Online. Inside Higher Ed. Available at http://www.insidehighered.com/news/2011/03/14/asian_university_leaders_consider_identity_of_their_institutions. Accessed March 14, 2011.

Koiller, B. 2007. Women on the challenges of being a scientist in Latin America and the Caribbean. Online. InterAmerican Development Bank. Available at http://www.iadb.org/en/news/webstories/2007-01-16/women-on-the-challenges-of-being-a-scientist. Accessed March 30, 2011.

Marginson, S. 2010. A Confucian tide. Online. Available at http://www.theage.com.au/national/education/a-confucian-tide-20101122-183ze.html. Accessed March 14, 2011.

Perkin, H., ed. 1991. History of universities in Altbach. Pp. 169-204. *International Higher Education: An Encyclopedia.* New York: Garland Publishing, Inc.

Stichweh, R. 1994. *Wissenschaft, Universität, Professionen: Soziologische Analysen*. Frankfurt am Main: Suhrkamp.

Vlahakis, G.N. 2006. *Imperialism and Science: Social Impact and Interaction*. Santa Barbara: ABC-CLIO.