We walked into the back of a junior level high school classroom with about 60 students seated in pairs at 30 double-desks. All were quietly studying. There was no teacher present! This was a study hall. My first reaction was that no American teacher would believe me, but my wife—an elementary teacher—was also with me and could confirm these observations. Education in China remains highly valued. Only the best students will have the opportunity to attend the limited number of colleges. These well-behaved students with a hard work ethic are the rule, not the exception.

This school was directly across the street from Henan Normal University (H.N.U.) and served as a lab school for this teacher’s college—Henan Normal University still calls such universities “normal schools” in translation. I had asked to observe a biology class and we were ushered into an advanced class of seniors, the best students being prepared for the Science Olympiad. Unlike other classes, there were only 40 students. Chairs were provided along the back wall and the visiting party including the principal, party secretary (political officer), other school officials and us sat at the back of the room. As soon as the bell rang, the teacher made an entrance from a side door at the front and all of us, from students to school officials, snapped to our feet. With a nod from the teacher, we all sat down. This level of regard sends a chill down your spine. An American teacher cannot imagine the level of respect that this engenders among students and colleagues, although some European schools have a similar custom.

Today’s lesson was a review session on the processes of transcription and translation, from DNA to protein production. I was handed the class textbook in Chinese and tried to follow along with the rapid-fire sequence of questions. Students raised their hands and stood when called on. This teacher would also call on those who did not raise their hands. Several students who did not know the answer obviously felt regret if not shame. The teacher quickly deferred to another student; there was no need to highlight that a student hadn’t studied enough. Some questions relied on rote memory, but most required full comprehension of the biochemical processes.

I took off my watch to switch it to stopwatch function. I knew that written Chinese characters were more compact than English, and a page of Chinese text equaled two pages of English. But this teacher was reviewing the concepts faster than I could mentally verbalize them in English, and the students had no difficulty following along. While my estimate was awkward and imprecise, I calculated that it would take me a minute-and-a-half to explain what he covered in one minute; the Chinese language is nearly 50 percent faster!

At the end of class, this teacher dismissed students two minutes early so they could ask the visiting American questions [and practice their English]. Many crowded to the back of the room but the foremost young man, who had elbowed past the others blurted out: “The new research on how neurons work; is that where God exists?”

Now the party officer sat second on my right, but his responsibility would be best described as advocate for national pride similar to our ROTC recruiter. Many Americans have misconceptions about religious repression in China. While respect for teachers means that a student doesn’t question a teacher’s authority, students read widely and some may ask more probing questions than do many U.S. students.

This opportunity to visit a public school occurred when I was in China to lecture on the American educational system at a two-week international biology educational conference at Henan Normal University in May, 1998. Henan Province in central China is China’s major wheat producer and officially the “sister state” to Kansas. H.N.U. is in Xinxiang, a city of several million north of the Yellow River. Equal to Kansas City, it is a small city by Chinese standards. The H.N.U. campus covers the same area as the Emporia State University campus, but while E.S.U. has under 6,000 students, H.N.U. serves nearly 40,000 including part time and night school. That is equivalent to bringing all of the University of Kansas students to Emporia, but not expanding the E.S.U. campus outward! Everywhere you see one American student here, envision five Chinese students in the same space. Streets and classes are very crowded. Student dormitory rooms are smaller than ours and generally sleep eight students in bunks. A university student therefore studies in the library or in empty classrooms at the end of the day, a habit they often keep when they come to America. When I returned to China in 2001 to lecture in Nanjing, Shanghai, Wuhan, and Inner Mongolia, I saw modern dormitories had been built to house only six undergraduate students, or four graduate students, per room.
Above: A biology master teacher at the lab school for Henan Normal University prepares a class of only 40 students for the science olympiad competition.

Above Right: Students fill every open space for calisthenics at this high school outside East China Normal University in Shanghai.

Right: Secondary levels students wear uniforms, a common practice outside the U.S.

Below: This beautiful library is the center of the new Nanjing Normal University campus that will triple the student capacity. China is rapidly expanding its universities in developed regions.

Left: Older student dormitories hold 8-9 students per room. Above: Newer dormitories at the new NNU campus only hold six per room.
China is fully adopting a free market system and the standard of living improves dramatically month-by-month. This has revealed a desperate shortage of Chinese universities. China has worked to secure primary education for its population but does not yet have the resources to give all a high school equivalency education. “Leaving exams” are given at several levels and determine who can enter the next school level. The “gao kao” is the big all-important exam at the end of high school and those with top grades can fill the limited university spaces. This test not only evaluates students, but also teachers, text materials, and schools. Simply, China has standardized education where the test drives the system.

Similar to other non-U.S. systems, China provides substantially more science coursework to its students and provides it earlier than does the United States. While China does not match the percentage of high school graduates of the U.S., it has a higher number of students attaining a higher level of science and math coursework.

Table 1. Chinese Public Educational System by Grade Levels and Courses

<table>
<thead>
<tr>
<th>Subject (periods per week)</th>
<th>PRIMARY GRADES:</th>
<th>SECONDARY:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1----2-----3----4----5----6</td>
<td>7----8----9</td>
</tr>
<tr>
<td></td>
<td>JUNIOR LEVEL</td>
<td>SENIOR LEVEL</td>
</tr>
<tr>
<td>Nature/Biology</td>
<td>1 2 2 2 2 2</td>
<td>2 2 - 2</td>
</tr>
<tr>
<td>Physics</td>
<td>- - - - - 2</td>
<td>3 3 3 3</td>
</tr>
<tr>
<td>Chemistry</td>
<td>- - - - - 2</td>
<td>3 3 3 3</td>
</tr>
<tr>
<td>Mathematics</td>
<td>6 6 6 6 5 5</td>
<td>5 5 5 5</td>
</tr>
</tbody>
</table>


This has important consequences for both the general public and for non-science school teachers. First, the general public has more knowledge of anatomy, medical problems, and basic biology at the end of junior level than do U.S. high school graduates. Second, elementary teachers are dramatically better prepared to confidently introduce basic biology, chemistry and physics concepts even if they received no additional college training in the sciences, which they do.

Secondary teachers receive college training in depth in their content field: history teachers study history, biology teachers study in biology departments, etc. (Table 3). Only one or two methods courses are taken, although some normal schools are redesigning teacher training with a bigger education component under the assumption that the solid U.S. economy is due to a superior educational system. Primary teachers study an elementary teaching curriculum at distinct schools for elementary teacher training. Although full three and four-year programs are listed and desired in the more developed and modernized areas, many teachers teach with less training, especially in rural areas of China.

Resources are limited and few public school science classes can equip students for individual experimentation. Teachers are lucky to be able to conduct single demonstrations, and this may be funded by the teacher out-of-pocket. Previous lack of labwork may be seen in Chinese graduates who come to the U.S. with extensive “book knowledge” but who must learn to use equipment and conduct genuine research. However, the new universities are much better equipped with labwork, and in some cases, the buildings are separated into lecture halls and laboratory buildings.

Table 2. Teacher Training Institutions

1) Four-year Normal Universities/Colleges
   for Secondary Teachers (B.A./B.S.)
   (shifan daxue/xueyuan)
2) Three-year Teacher Colleges
   for Teachers (no bachelors degree)
   (shifan zuanke xuexiao)
3) Four-year Colleges for Primary Teachers
   (zhongshifan zuanke xuexiao)
4) Inservice is provided by separate institutes.
   (jiaoyu xueyuan, jiaoshijinxiu xuexiao)


The effectiveness of their public educational system is obvious in several ways. China is no longer educating a small elite. The large numbers who complete junior level secondary coursework are substantially more science literate than U.S. high school graduates. A proportion of those who major in science as college undergraduates come to the United States where they are by far the leading foreign recipients of U.S. doctorate degrees in science and engineering. At the present time, over 70 percent of U.S. doctorates in engineering go to foreign-born students as do over half of U.S. chemistry and physics doctorates, and this percentages are climbing. The combination of a foreign public school education and
a U.S. graduate education is becoming a major pipeline for U.S. scientists. With a shortage of colleges and research universities, China continues to liberally grant passports to their best students in the hope that many will return after receiving their doctorates.

China is in the midst of reforming their educational system. Before the mid-1990s, any student who scored at the top of his cohort was assured a free university education, including room-and-board. Professors were hired for life and housed free on-campus. Teacher pay was low, classrooms were austere, and life was difficult for both professors and students with little prospect for change. College graduates were placed in nearby vacancies that might not match their training. There was little competition but maximum security.

Today, Chinese universities charge tuition to some extent that is fairly comparable to U.S. college tuition based on a proportion of an average person's income in China. Professors must purchase their on-campus apartments, and some universities hire professors away from others. The tuition underwrites the expenses of running the university and the government provides funds for new buildings and facilities. The top universities are often expanding capacity by three times. One strategy is to build a new branch campus outside of the city, move undergraduate courses there, and renovate the old downtown campus into a graduate school. Professors may take on extra class loads for extra pay, and the new and reconditioned classrooms sport modern computer and audiovisual equipment. Students who graduate travel widely without restrictions and are competing for jobs.

Table 3. Average Biology Teacher-training Program Before Current Reforms (class hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Lecture</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of CCP</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Political Economy</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Philosophy</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Foreign Language</td>
<td>268</td>
<td></td>
</tr>
<tr>
<td>Physical Training</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Psychology</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Pedagogy</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Methodology</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Chinese Literature</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>84 24</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>159 120</td>
<td></td>
</tr>
<tr>
<td>Biochemistry</td>
<td>80 48</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>650 510</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>20 20</td>
<td></td>
</tr>
<tr>
<td>Special English</td>
<td>150 38</td>
<td></td>
</tr>
</tbody>
</table>


Figure 1. Timeline of major phases in the history of the People's Republic of China. Teachers trained before the Cultural Revolution have now retired and been replaced by a much younger generation trained after the Cultural Revolution. With no gradual continuity of leadership, the changes in education reform and leadership are dramatic.

However, not all educational changes are just the result of current economic and political reforms. A major upheaval occurred in China from 1965 to 1974 called the "Cultural Revolution." Schools, including universities, closed down during this anti-intellectual era and a generation was "lost" from lack of education. That means that there are currently no older middle-aged administrators or professors. As the veteran education leadership educated before the Cultural Revolution retired off, they have been replaced by very young educators. This has been a formula for very rapid and dramatic change in politics, business, and education, and has permitted the adoption of new methodologies and reforms. The Chinese education leadership is well aware that their old standardized teach-to-the-test system has promoted memorization and shortchanged creativity. They are very eager to adopt those aspects of American education that promote creativity and science discovery.

Kansas teachers may be growing weary from over two decades of faddish education reforms, but our "reform" movement is a minor tremor compared to the earthquakes occurring in Chinese education.

REFERENCES
COULD HANDEDNESS BE GENETIC?  
...A CRITICAL THINKING PROBLEM FOR GROUPS

A. A student proposes that handedness is inherited and that left-handedness is a recessive trait that is therefore hidden in much of human the population. The model proposes this is a simple system where you get one gene from each parent: two right-hand genes (RR) or one-right-and-one-left (Rr) will result in a right-handed person; only inheriting two left hand genes (rr) would produce a left-handed person.

Step 1. Survey your population of students. How many are left-handed (supposedly "rr")?

Step 2. However, some of the right-handed students would be “carriers” of the left hand gene (Rr).

How can we estimate this population? A biologist and a mathematician developed a formula that reveals the likely number of carriers. According to this Hardy-Weinberg formula, the right-hand genes and left-hand genes in the population will total to 100 percent or (p + q = 1.0) where p and q are any two forms (alleles) of genes. That makes sense because it means that if one gene makes up 30% of the gene population, then the remaining makes up 70% (or q = 1 – p). And the relationship of the “pure” right-handed (RR or homozygous dominant), right-handed but-carriers (Rr or heterozygous), and left-handed (rr or homozygous recessive) will be:

\[ p^2 + 2pq + q^2 = 1 \]

The number determined in Step 1 above, expressed as a percent of the population, constitutes the “\( q^2 \)” component of this equation. If 16 out of 100 people were left handed (rr), then \( q^2 = 0.16 \) and \( q = 0.4 \). The frequency of the other gene then must equal 0.6 (since \( p = 1 - q \)), another way of saying that the two genes make up 100% of the possible forms of the gene. The number who are heterozygous (or Rr) “carriers” equals the middle term “\( 2pq \)” or \( 2(0.6 \times 0.4) = 0.48 \). Therefore, the likely numbers of students with various gene combinations in this case is:

0.36 with two right-handedness genes (RR) + 0.48 right-handed but carriers (Rr) + 0.16 left-handed (rr) = 1.0

Therefore, how many in class are likely to have two right-handedness (RR) genes? How many would likely be carriers (Rr)?

B. Another student proposes that handedness could just as easily be passed to children by how the parents carry the child and interact with it, such as feeding a child face-to-face where the child’s left hand would get in the way of a parent’s right hand, therefore promoting the child’s use of its right hand also. This would argue for the learning process alone perpetuating the parents’ handedness. Assuming all parents and children are expressing their “true” handedness, whether genetic or learned, the occurrence of which case below would cast the most serious doubt on a simple genetic basis for handedness with left handedness recessive?

a. two right-handed parents have a left-handed child  
b. two left-handed parents have a right-handed child  
c. left-handed parents only have left-handed children  
d. right-handed parents only have right-handed children  
e. none of the above cases would challenge a genetic theory of handedness

(Answer: b; two left-handed recessive parents (rr) would lack any right-handed dominant gene to pass to their children.)

Extra Study Example: A survey of a class of 36 students finds that 27 (0.75) are right-handed and 9 (0.25) are left-handed. Using the Hardy-Weinberg formula, what would be the expected number of students with two right-handedness genes (homozygous dominant), and the number right-handed but carrying one left-handedness gene (heterozygous dominant)?

\[ q^2 = 0.25 \]

...therefore \( q = 0.5 \)

...therefore \( p = 1.0 - 0.5 = 0.5 \); \( p^2 = 0.25 \)

...therefore, 0.25 would have right-handedness genes only, and 0.50 carriers, and 0.25 would have left-handedness genes only. —C. Schrock & J.R. Schrock