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AN AMERICAN MATHEMATICIAN'S PERSPECTIVE ON MULTIPLE-CHOICE TESTS

Mathematics is a central part of human culture. Like music and literature, it is a language of human thought. In discussing math education in Vietnam, it is important to note that Vietnam already has a strong tradition to build upon. Mathematics in Vietnam goes back to ancient times. Over five hundred years ago in Hanoi the name of Luong The Vinh, an expert in geometry, was inscribed on a stele of honor in Van Mieu. Over sixty years ago, during the war against French colonialism, the Viet Minh published a geometry textbook written by the eminent mathematician Hoang Tuy for schools in the liberated zones. I know of no other case anywhere in the world where a guerrilla press in the jungle published a math book! And of course a more recent example of the strength of the mathematical tradition of Vietnam was the awarding of the Fields Medal to Ngo Bao Chau at the 2010 International Congress of Mathematicians.

Mathematics in the schools is crucially important for several reasons. First of all, it teaches children how to think in a logical, rational way free of bias. Second, mathematics is “objective,” meaning that it can be a basis of fair comparisons between students. Third – and most importantly – mathematics is a “gateway” to many careers and is a tool for solving problems of the economy and society.

I have visited schools in Vietnam, and have been tremendously impressed with the youngsters' high level of understanding of basic mathematics. I have also seen the questions on Vietnam's university entrance exam in mathematics, which is a very difficult exam by international standards.

In my opinion, in Vietnam – as in other countries of East Asia that have a strong mathematical tradition (China, Taiwan, Japan, and Korea) – the most important deficiency in math education is that only formal “pure” mathematics is emphasized, and students do not learn much about applications. Math classes should include more applications – what in the U.S. are called “word problems” or “story problems.” I believe that Vietnam should gradually introduce such problems into the school programs in mathematics at all levels.

There has been much discussion in Vietnam about how to assess student performance in mathematics, and there has been controversy about the idea of using multiple-choice tests. The Association of Vietnamese Mathematicians has warned that the use of such tests will cause students to memorize tricks rather than developing a logical understanding of the subject. I want to comment on this issue based on our experience in the U.S.

In the U.S., students receive marks from their teachers that are partly based on exams and partly based on other things (such as participation in class and homework). At certain times they also take multiple-choice standardized tests. At the primary and secondary levels these are generally used to evaluate the teachers and schools, not the students. The idea is that these exams can be easily graded by computer, and then comparisons can be made. A school or teacher whose students perform worse than the average and do not

increase their scores from one year to the next can then be “punished” in various ways – in extreme cases the school can be closed.

This use of standardized tests is very controversial in my country, and is strongly opposed by teachers’ unions and most education experts. In some of the best schools the parents and teachers believe that they are good judges of quality and their evaluations cannot be helped by multiple-choice tests. As a result, they have refused to give these tests.

The policy of evaluating teachers and schools based on student performance on multiple-choice tests started about 15 years ago during the Bush administration and continued during the Obama administration. Most scientists and educators believe that this policy has been a failure, and that American schools have not improved but rather have declined during this period. In a best-selling book published in 2010, education expert Diane Ravitch, a prominent education official during the Bush administration and early advocate of standardized testing, reversed her position. She is now a leading opponent of the extensive use of standardized multiple-choice tests.

The policy created tremendous pressure on teachers to “teach to the test” and avoid in-depth or conceptual teaching. In many cases it also led to corruption and cheating (teachers or administrators changing students’ answers after the test in order to raise their scores).

In the U.S., an exam called the Scholastic Aptitude Test (SAT) is used as part of the university admissions process. Earlier the SAT was entirely a multiple-choice test. But several years ago many universities stopped using the SAT for admissions because they did not feel that multiple-choice tests were a useful way to decide which students to admit. When this happened, the company that produces the SAT, the Educational Testing Service (ETS), became worried and introduced an essay part of the test so that most universities would continue using the SAT.

It is important to note that American universities never base admissions decisions entirely on exam scores. Even universities that use the SAT also rely on other methods of evaluating students, such as high school marks, letters of recommendation from teachers, special essays written by students for the application, and personal interviews. Unfortunately, some of these methods are unreliable (for example, students’ parents might write the essays, and both marks and letters of recommendation are usually very inflated). Nevertheless, university admissions officials believe that through the use of many different tools they can get a much better evaluation of applicants than if they were to rely only on an admissions exam.

It is difficult to design a fair and useful multiple-choice test. Much research has been devoted to this question. The ETS spends a large amount of money on the design of its multiple-choice tests. When a multiple-choice test is well designed, it has two main advantages: (1) it costs very little to correct and mark, since that can be done by machine, and (2) it can be used to eliminate the very weakest students. That is, a student who does very poorly on a multiple-choice test should not be a likely candidate for admission

to a top university. However, multiple-choice tests are incapable of identifying exceptional, outstanding students.

Thus, if the Vietnamese government needs to reduce the cost of marking the entrance exams, there is a valid way to do this — a compromise that would probably not adversely affect the selection process. The entrance exam could have two parts – a multiple-choice part and a long-answer part. Students who score below a certain minimal level on the first part would be eliminated, and the second part of their exams would not be marked. That is, the first part would identify many of the weakest students, and the second part would determine who the very good students are. This would save time and expense without sacrificing quality.

A drawback of multiple-choice tests is that they fail to prepare students for the type of problem-solving they will do in university math and science courses and in their future careers. In the “real world,” mathematicians and scientists do not solve short-answer questions. Long, multi-step problems, in which the students must show their full solutions, are good preparation for careers in science and technology.

I teach first-year university students. In our course in calculus we emphasize applications. Our final examination at the end of the term lasts about 3 hours and typically has about 8 problems, of which about half are “story problems.” The students are required to show the details of their solutions, not just the final answers. My colleagues and I do not use multiple-choice tests to evaluate students at the university level.

The higher one goes in the educational system, the less multiple-choice tests are used. A good university would never rely primarily on multiple-choice tests to determine whom to admit. However, multiple-choice tests are sometimes useful at the advanced level – for example, the Graduate Records Exam (GRE) – in identifying the very weakest students, who can be immediately eliminated.

The university with the best mathematics admissions exam that I have heard about is Cambridge University in England, which has a well-deserved reputation as one of the very best universities in the world. The exam is the final stage of the selection process for students who wish to study mathematics at Cambridge. It is administered by math instructors, who give applicants a set of difficult problems and tell them that they are not expected to fully solve them all. After an hour or two, the examiners take the applicants’ solutions or partial solutions and interview them about the thought processes that went into their solutions, and especially about the points where they got stuck. An applicant whose problem-solving abilities and depth of understanding make a good impression on the examiners will be admitted to Cambridge.

Some people in Vietnam seem to believe that a good strategy for progress in education is to imitate the United States. This is misguided. It is true that American post-graduate education is very good by international standards. But this is in part due to the large number of foreign students; in many of the best science departments the majority of the strongest PhD students are foreigners who received their earlier education in other countries.

At the grade school level, the American system rates poorly in international comparisons. Some of the leading experts in education believe that the U.S. can learn a lot from other countries that have much better schools. Diane Ravitch has been urging Americans to adopt the approaches used in Finland, and James Stigler, a leading specialist in math education at UCLA, has long advocated importing Japanese methods (especially the “lesson study” technique) to America.

Both Ravitch and Stigler – and many others, including me – believe that the most important requirement for successful math education is a well-trained and well-treated teaching profession. Teachers must have adequate pay and good working conditions. They need to be given time off from teaching to raise their qualifications and to collaborate with other teachers to improve their classes. They need to be respected by the public. Parents must not be allowed to bribe or intimidate teachers.

From my observations it seems that in some ways Vietnam is ahead of the United States. In Vietnamese culture, teachers are greatly respected. Students study hard, and they behave well in school. They do not threaten or insult their teachers. Teachers are not used as scapegoats and whipping-boys by politicians, as often happens in America.

In education the human element is primary, and technology is secondary. Of course, it’s very convenient that a computer can quickly mark a million multiple-choice tests. But it takes a human to make a reliable evaluation of someone’s potential and intelligence.