Addressing the Skills Gap for Students and Young Adults
By Eric Gaze

The latest research from the Education Testing Service Center for Research on Human Capital and Education showed that U.S. students across all socioeconomic levels scored lower than students in most countries around the world in literacy, numeracy, and problem-solving skills. The study examined millennials born between 1980 and the early 2000s ages 16 – 34 and measured the 21st century skills needed by individuals to make measurable improvements in their life and to prosper professionally. The results were disappointing for both the wealthiest cohorts of students, as well as students from lower socioeconomic and minority groups. While these students are attaining the highest levels of education ever, their scores indicate a worrisome skills gap.

Of particular concern is the percentage of students scoring below the minimum numeracy standard (below level 3): 54% White, 83% Hispanic and 88% of Black millennials did not achieve this minimum benchmark. Controlling for educational attainment makes the White-Black gap even more telling.

Table 1: Percentage of U.S. adults scoring below minimum standard for numeracy by race/ethnicity and educational attainment

% Below Level 3	**Race/ethnicity**		
	White	Black	Hispanic
Lower secondary or less	94%	100%	99%
Upper secondary (High School graduate)	71	**95**	**86**
Post secondary (non bachelor's degree)	58	**91**	
Bachelor's Degree	29	**71**	

Source: Organization for Economic and Co-operation and Development (OECD), Programme for International Assessment of Adult Competencies (PIAAC) 2012

It is to be expected that students who do not graduate from high school to be uniformly quantitatively illiterate as evidenced by the near 100% scoring below level 3 in the first row of the table. As white students complete more years of education, the percentage that are quantitatively illiterate steadily drops. Shockingly, however, increasing levels of educational attainment does little to improve black students' quantitative literacy. Recent research papers[1] linking racism to higher mortality rates point to the pervasiveness and severity of racial inequality in our country. Many point to education as the answer, but table 1 is clearly showing that not all educational opportunities are created equally. In our data driven society, economic success is strongly linked to numeracy[2]. If we truly want to provide access to the "American dream" for all of our students, it is imperative that we address the failings and inequities of our current educational system, and the mathematics curriculum in particular.

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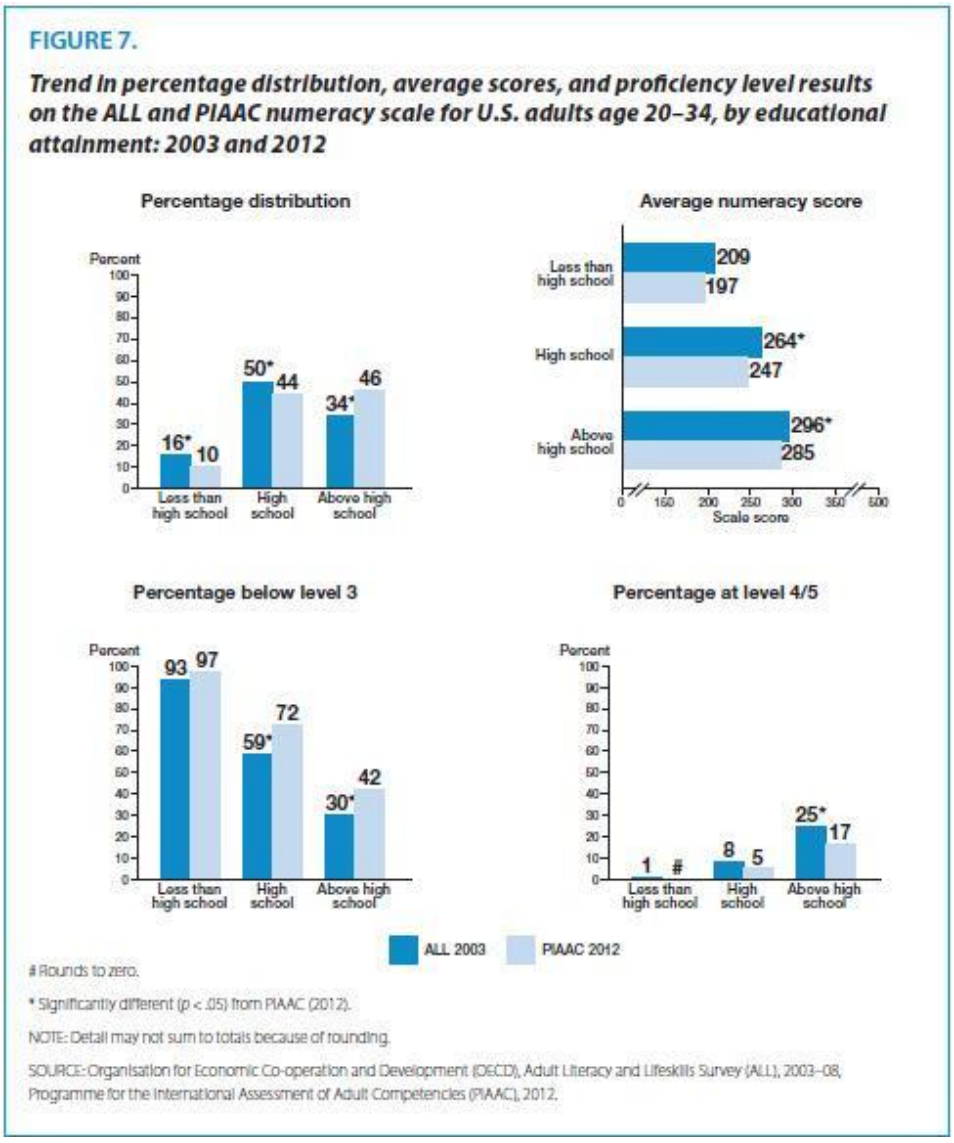
1 Chae DH, Clouston S, Hatzenbuehler ML, Kramer MR, Cooper HLF, et al. (2015) Association between an Internet-Based Measure of Area Racism and Black Mortality. PLoS ONE 10(4): e0122963. doi:10.1371/journal.pone.0122963

2 David Autor, "Skills, Education, and the Rise of Earnings Inequality Among the 'Other 99 Percent.' " Science Magazine, May 23, 2014, 843-51. http://dx.doi.org/10.1126/science.1251868.

These new results from PIAAC are not surprising because the Programme for International Student Assessment (PISA) data has consistently indicated that U.S. students have lagged behind their counterparts in other countries. Thus, it would be expected that millennials would not have magically acquired skills to put them ahead of other adults around the world. The Adult Literacy and Lifeskills Survey (ALL) conducted between 2003-2008 established that U.S. adults were near the bottom of such skills compared to their international peers. The problem is getting worse, as shown in the following graphic comparing ALL to the Survey of Adult Skills (PIAAC) results (See Figure 1):

Figure 1. Comparison Between ALL and PIAAC Survey Results



To address the skills gap, educators need to know what assessment questions and levels are being used. For numeracy, the average score of U.S. millennials was 255, which was the lowest of all countries in this cohort (black millennials averaged 219). A typical PIAAC

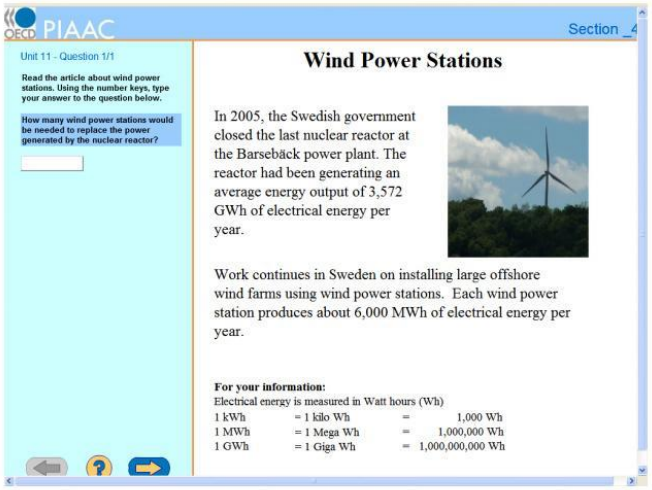
question at level 2 with a difficulty score of 250, is to compute reimbursement for a trip with mileage given (in a logbook) and the rate of $0.35 per mile and $40.00 per day also given. Roughly half of students cannot do this. A level 3 question asks students to look at plans for making a cardboard box with given dimensions, and then decide which of four available plans best represents the assembled box. A level 4 question (the highest level for numeracy) asks students to interpret a stacked bar graph with percentages as the dependent variable and years on the x-axis. Only 17% of students with education "above high school" can correctly answer questions like this! Another question of "medium" difficulty involved units (See Figure 2):

Figure 2. PIAAC Wind Power Stations Item

Sample Item 2: Wind power stations

This sample item (of medium difficulty) focuses on the following aspects of the numeracy construct:

Content	Quantity and Number
Process	Act upon, use (compute)
Context	Community and society



These examples emphasize the crucial aspect of proportional reasoning involved in all of them. Rates, units, dimensional analysis, percentages, and visual displays of quantitative information are all middle school math topics that are largely abandoned in high school in our single-minded pursuit of algebra. We need a robust curriculum that develops these skills that are so critical to the ways in which in we use quantitative information in our daily lives. Educators must continue the development of high quality Quantitative Reasoning courses that emphasize the sophisticated reasoning used in elementary mathematics, that is required in these examples.

The PIAAC results also highlighted that U.S. millennials scored lower than international students in problem solving in technology-rich environments.

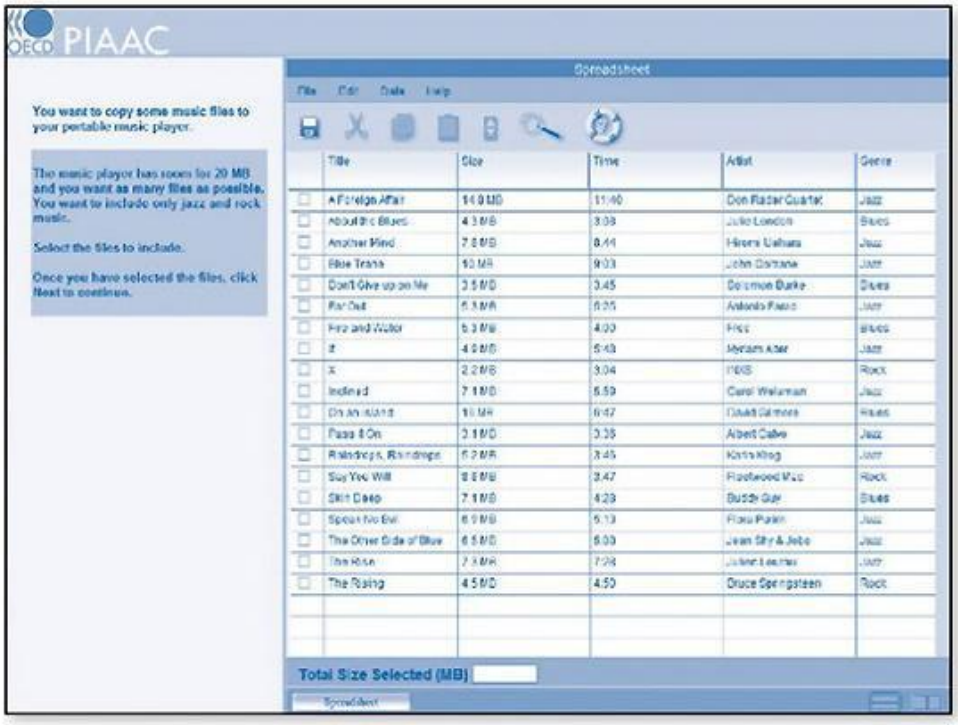
For example, a typical medium level difficulty item (See Figure 3) asks adults to "Organize large amounts of information in a multiple column worksheet using multiple explicit criteria."

Figure 3. PIAAC Medium Level Difficulty Item

Sample Item 2

In this item of level 2 difficulty, respondents select a set of files to download onto a portable music player. The files must meet specified criteria in terms of genre (jazz and rock) and not exceed the capacity of the device (maximum of 20 MB).

The software includes an automatic summing functionality ("Total Size Selected") that facilitates the task by updating the total file size as files are selected or de-selected. Respondents must monitor progress as they select files, checking against the specified criteria to know when they have satisfied the constraints presented in the problem.



It is also possible to sort the spreadsheet by file size and/or genre, a strategy that can improve task efficiency. The connection between the use of resources in a technology-rich environment and resulting efficiencies for solving problems is emphasised in the framework and therefore included across items in the assessment.

The mathematics education community needs to embrace spreadsheets as the technology of choice in our mathematics classrooms. We truly do live in a data driven society, and this is evidenced by the questions in both the numeracy and technology sections of PIAAC. Students working with spreadsheets learn not only how to organize and clean data, but also vital skills in how best to create visual displays of quantitative information for effective communication. Algebraic reasoning is also developed via the input/output interface and the

cell references involved in entering formulas. In my *Thinking Quantitatively* QR course, I emphasize spreadsheets and proportional reasoning throughout; developing the critical skills students need for informed decision making in their personal, professional, and civic lives. These are the skills students need to fully participate in the 21st century, a world awash in numbers. Don't take my word for it, I encourage you to read the OECD's report.

About Eric Gaze

Eric Gaze directs the Quantitative Reasoning (QR) program at Bowdoin College, and is a Lecturer in the Mathematics Department. He is the current President of the National Numeracy Network (NNN 2013 – 2015). Eric has given talks and led workshops on the topics of QR course development and assessment. He is the Principal Investigator for a NSF TUES Type I grant (2012-14), Quantitative Literacy and Reasoning Assessment (QLRA) DUE 1140562. Prior to coming to Bowdoin, Eric led the development of a Masters in Numeracy program for K-12 teachers at Alfred University as an Associate Professor of Mathematics and Education.