

What Mathematics Do People Really Use in the Workplace?

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There are tests for workplace mathematics, some quite good



Table 24

Correlations between WorkKeys® *Applied* Mathematics Level Scores and Job Performance Ratings

Study	Sample Size	Correlation
1	142	0.41
2	27	0.41
3	24	0.41
4	141	0.41
5	56	0.34
6	120	0.23

ACT has profiled over 16,000 jobs and designed this test to match the math needed in over 90% of those jobs.

Cognitive skills tests in general are much better at predicting who will be “successful on the job” than a degree does

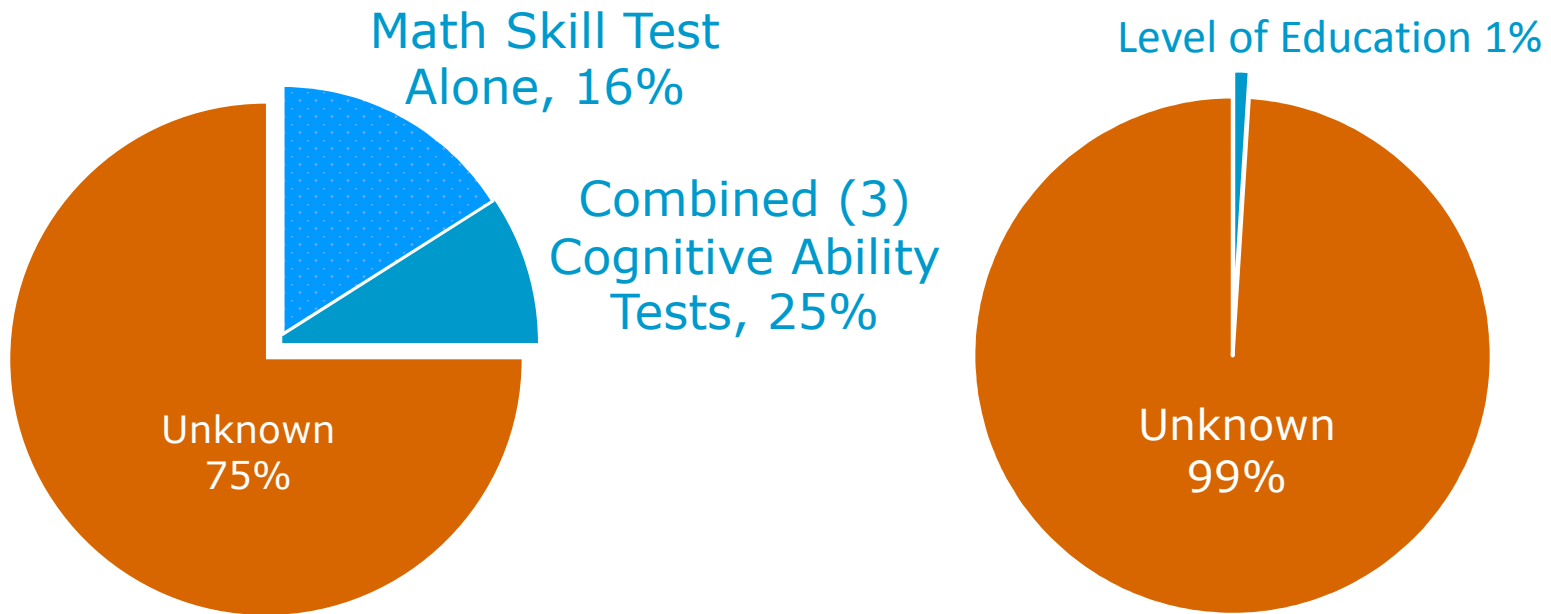
Predictor	Validity		No. of studies	Total subjects
	<i>M</i>	<i>SD</i>		
Hunter and Hunter (1984) ^a				
Ability composite	.53	.15	425	32,124
Job tryout	.44	—	20	—
Biographical inventory	.37	.10	1	4,429
Reference check	.26	.09	10	5,389
Experience	.18	—	425	32,124
Interview	.14	.05	10	2,694
Training and experience ratings	.13	—	65	—
Academic achievement	.11	.00	11	1,089
!!! Education	.10	—	425	32,124
Interest	.10	.11	3	1,789
Age	-.01	—	425	32,124

Ability Composite = measurement of 3 cognitive skills, strongest predictor of on-the-job performance

WorkKeys Math Test = 1 cognitive skill, little less strong predictor

Another way of looking at the numbers

VARIATION IN INDIVIDUALS' ON-THE-JOB PERFORMANCE IS SUCCESSFULLY EXPLAINED BY:



These numbers are the prior validity numbers, squared.



Skills (Ability Composite) tests predict performance on complex jobs better than simple jobs

JOB COMPLEXITY <small>(as determined from DOL's "data" dimension in its Dictionary of Occupational Titles)</small>	HOW WELL SKILLS TESTING PREDICTS PERFORMANCE (RAW VALIDITY) <small>1 = perfect prediction of performance 0 = zero ability to predict performance</small>
High Complexity	.58
Medium Complexity	.51
Low Complexity	.40
Unskilled	.23

Literature supporting validity of .3 to .6 for cognitive skill tests' prediction of job performance

Literally over
1,000 studies,
over 40 years and
many job types.

- M.M. Olea and M.J. Ree, *J. Appl. Psych* 79, 845-851 (1994).
- M.H. Ree, J.A. Earles and M. Teachout, *J. Appl. Psych* 79, 518-524 (1994).
- K. Brown, H. Le and F.L. Schmidt, *Intl. J. Selection and Assessment* 14, 87-100 (2006).
- Schmidt, Ones, and Hunter, *Ann. Review Psych* 43, 627-70 (1992).
- J.E. Hunter and R.F. Hunter, *Psych Bull* 96, 72-98 (1984) Also: a full decade of papers by Hunter from 1980-1990, covering an enormous number of datasets.
- K. Pearlman, F.L. Schmidt and J.E. Hunter, *J. Appl. Psych* 65, 373-406 (1980).
- F.L. Schmidt, J.E. Hunter, and J.R. Caplan, *J. Appl. Psych* 66, 261-273 (1981).
- L.C. Northrup, *Validity Generalization Results for Apprentice and Helper-Trainer Positions*. Washington, DC: U.S. Office of Personnel Management, Office of Staffing Policy (1986).
- J.A. Hartigan and A.K. Wigdor, *Fairness in Employment Testing: Validity Generalization, Minority Issues, and the General Aptitude Test Battery*. Washington, DC: National Academy of Sciences (1989).
- E.E. Ghiselli, *The Validity of Occupational Aptitude Tests*. New York: Wiley, 1966. (1966), Also: E.E. Ghiselli, *Personnel Psych.* 26 461-477. (1973).
- J.F. Salgado, H. Anderson, S. Moscoso, C. Berta and F. De Fruyt, *Personnel Psych* 56, 573-605 (2003).
- H.R. Hirsch, L.C. Northrup, and F.L. Schmidt, *Personnel Psych* 39, 399-420 (1986).
- M.H. Trattner, *The Validity of Aptitude and Ability Tests for Semiprofessional Occupations Using the Schmidt-Hunter Interactive Validity Generalization Procedures*. Washington, DC: U.S. Office of Personnel Management, Office of Staffing Policy (1988).

When used in hiring, cognitive skills tests deliver real-world results

EMPLOYER	POSITIONS FILLED (Using WorkKeys®)	OUTCOMES (compared to prior practices)
BERNER FOOD AND BEVERAGE (Dakota, IL)	Food production.	95% REDUCTION in worker's compensation. 80% REDUCTION in cost of nonconforming product. Longest run to date without a lost-time injury. Turnover now down to 2%.
FARMINGTON PUBLIC LIBRARY (Farmington, NM)	Library clerk.	Cost-to-hire REDUCED 70% ; time-to-hire REDUCED 60% . applicant pool TRIMMED BY 78% .
BUCKMAN REGIONAL WATER TREATMENT PLANT (Santa Fe, NM)	All positions within the company.	0 turnover after one year.
PGT INDUSTRIES (Salisbury, NC and Venice, FL)	Manufacturing, glass processing, and logistics.	30% REDUCTION in turnover; 50% REDUCTION in training costs; 50% REDUCTION in training time.
ENERGIZER (Dakota, IL)	Production operators, electricians, equipment mechanics, anode room operators.	Skills-related TURNOVER IS NOW 0.
CG POWER SYSTEMS (Dakota, IL)	17 different positions.	TURNOVER <3%



When used in hiring, cognitive skills tests deliver real world results

EMPLOYER

OUTCOMES (compared to prior practices)

SUBARU AUTOMOTIVE

25% **REDUCTION** in turnover.

COVIDIAN HEALTH
CARE

28 DAYS SAVED in time-to-hire. **\$1,700 SAVINGS** in hiring cost per person. **1.5 YEARS** saved in time-to-full employee efficiency.

STEELSCAPE

<4% **OVERALL** turnover.

INOVA HEALTH SYSTEM

73% REDUCTION in turnover; **\$1.8 MILLION** cost savings.

BRADNER VILLAGE,
A RETIREMENT
COMMUNITY

37% **DOWN** in turnover.

911 CALL CENTER

53% REDUCTION in turnover; **0%** skills-related turnover.



New Options
NEW MEXICO

Powered by
www.newoptions.org

So We Have A Test of Workplace Math
that Accurately Predicts Workplace
Performance.

How Is It Different from
“School Math”?



Content is different

Math Through 6th Grade Only.

INCLUDED

- Addition, subtraction, multiplication, division (these operations for negative numbers as well), fractions, decimals, percentages, mixed numbers, unit conversions, averages & other simple statistics, ratios, rates, order of operations, perimeters, areas, volumes.

NOT INCLUDED

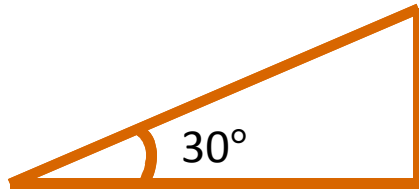
- Trigonometry, Pre-Calculus, Calculus. Algebra is not explicitly included but is useful for problems involving more complex order-of-operations.



Context is different

- All problems are highly plausible “on-the-job” situations.
- None of the problems has explicit math.
 - No “find the common denominator.”
 - No written formulas you are told to rearrange or solve.
 - YOU must interpret the English in terms of math and YOU must choose the correct math tools to solve the problem.
- All problems are “word problems.”

Scoring scheme is different



$$2+2=?$$

A. What is the sin of 30?

B. What is the sum of 2+2?

- School Math View: Problem A is harder than Problem B because A is trigonometry (taught in 9th grade) and B is arithmetic (taught in 2nd grade).
- Workplace Math View: Problem A and Problem B are the same. Both require simple memorization of a fact. There is no way to solve either problem using reasoning or deduction. Thus, both questions measure math skill at a sub-literate level.

In tests of workplace math skill, higher-level questions have the following features:

- More and more extraneous information to sort through.
- More and more rearranging of information required to get to the answer.
- More and more chained steps. Sequencing is important.

IN SUM: Workplace Math is “critical thinking,” as applied to math.



Applied Mathematics Level 3

(Qualified for entry-level job)

SAMPLE ITEM:*

In your job as a cashier, a customer gives you a \$20 bill to pay for a can of coffee that costs \$3.84. How much change should you give back?

- A. \$15.26
- B. \$16.16
- C. \$16.26
- D. \$16.84
- E. \$17.16

Applied Mathematics Level 5

(Qualified for skilled labor or college)



SAMPLE ITEM:*

Quick Call charges 18 cents per minute for long-distance calls. Econo Phone totals your phone usage each month and rounds the number of minutes up to the nearest 15 minutes. It then charges \$7.90 per hour of phone usage, dividing this into 15-minute segments if you use less than a full hour. If your office makes 5 hours 3 minutes worth of calls this month using the company with the lower price, how much will these calls cost?

- A. \$39.50
- B. \$41.48
- C. \$41.87
- D. \$54.00

*From WorkKeys[®] Applied Mathematics Test, Level 5. WorkKeys is a registered trademark of ACT, Inc. For more information please visit <http://www.act.org/products/workforce-act-workkeys/>

Applied Mathematics Level 7

(Qualified for professional level work)



SAMPLE ITEM:*

The farm where you just started working has a vertical cylindrical oil tank that is 2.5 feet across on the inside. The depth of the oil in the tank is 2 feet. If 1 cubic foot of space holds 7.48 gallons, about how many gallons of oil are left in the tank?

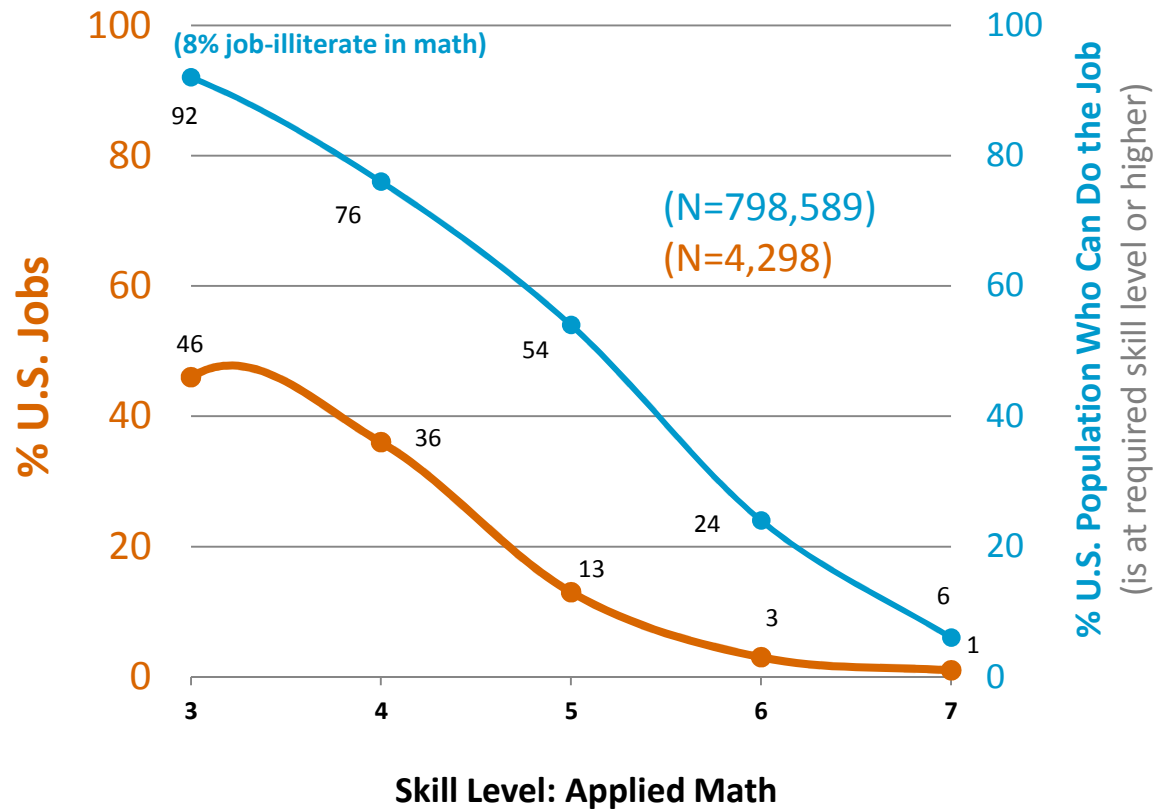
- A. 37
- B. 59
- C. 73
- D. 230
- E. 294

*From WorkKeys[®] Applied Mathematics Test, Level 7. WorkKeys is a registered trademark of ACT, Inc. For more information please visit <http://www.act.org/products/workforce-act-workkeys/>

If We Measure the U.S. Population Against U.S. Jobs in Terms of Workplace Math Requirements, What Do We Find?

(Un)fortunately For The U.S., Most U.S. Jobs Don't Require Much Math

WorkKeys® APPLIED MATH



However, some important jobs do (List Of Occupations Requiring AM Level 7)



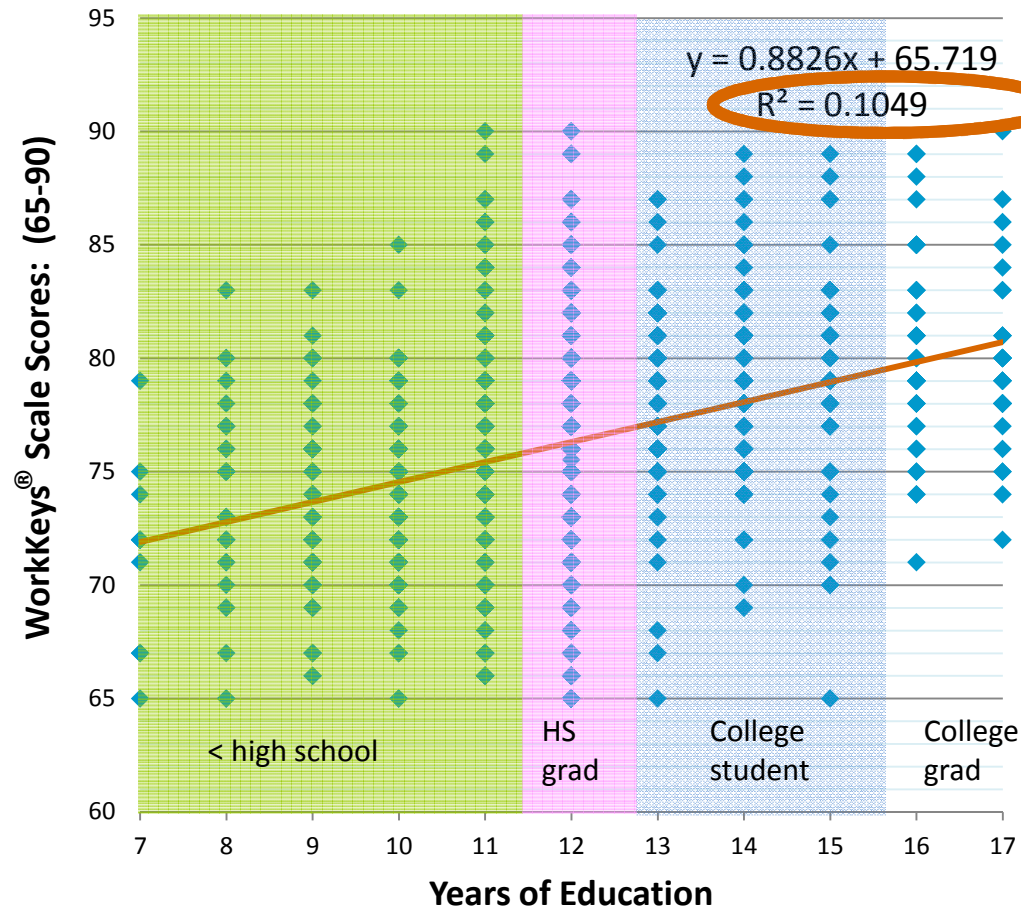
O*Net Code	Title	Clusters
17-2011.00	Aerospace Engineers	Science, Technology, Engineering & Mathematics
17-2021.00	Agricultural Engineers	Science, Technology, Engineering & Mathematics
17-1011.00	Architects, Except Landscape and Naval	Architecture & Construction
17-2031.00	Biomedical Engineers	Science, Technology, Engineering & Mathematics
17-2041.00	Chemical Engineers	Science, Technology, Engineering & Mathematics
17-2051.00	Civil Engineers	Science, Technology, Engineering & Mathematics
15-1011.00	Computer and Information Scientists, Rese...	Health Science; Info Tech
17-2061.00	Computer Hardware Engineers	Info Tech; Sci / Tech / Eng / Math
15-1031.00	Computer Software Engineers, Applications	Health Science; Info Tech; Manufacturing; Sci / Tech / Eng / Math
11-9041.00	Engineering Managers	Arch / Construction; Gov / Public Admin; Info Tech; Sci / Tech / Eng...
11-1021.00	General and Operations Managers	Bus / Mgmt / Admin; Gov / Public Admin
17-2111.00	Health and Safety Engineers, Except Minin...	Science, Technology, Engineering & Mathematics
17-2121.02	Marine Architects	Science, Technology, Engineering & Mathematics
17-2121.01	Marine Engineers	Science, Technology, Engineering & Mathematics
17-2121.00	Marine Engineers and Naval Architects	Science, Technology, Engineering & Mathematics
17-2131.00	Materials Engineers	Science, Technology, Engineering & Mathematics
19-2032.00	Materials Scientists	Science, Technology, Engineering & Mathematics
17-2151.00	Mining and Geological Engineers, Includin...	Science, Technology, Engineering & Mathematics
17-2161.00	Nuclear Engineers	Science, Technology, Engineering & Mathematics
17-2171.00	Petroleum Engineers	Science, Technology, Engineering & Mathematics
19-2012.00	Physicists	Health Science; Sci / Tech / Eng / Math
17-2111.03	Product Safety Engineers	Science, Technology, Engineering & Mathematics

From the ACT, Inc occupational database at http://profiles.keytrain.com/profile_search/

But why can only 6% of the U.S. population score a level 7 in 6th grade math?

The ability to code a “real situation” into math, i.e., to **apply** math, is almost never taught and completely missing, not only in K-12 but also the graduate level. This may also explain the U.S.’ poor PISA results.

Only 10% of an individual's ability to apply math, can be explained by years in school



Correlation= .32
N=1809

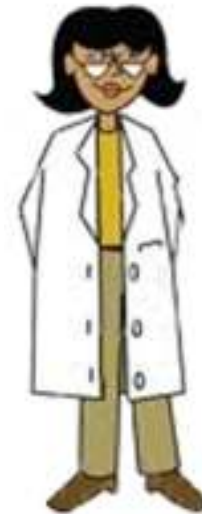
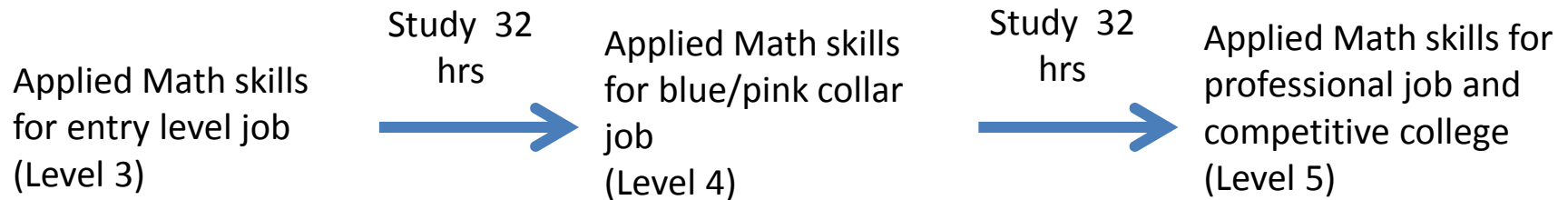
Targeted curricula can do in one year what it takes school 6 years to accomplish

	Applied Math Gain
Keytrain (California data, Kilijanek analysis)	5.8/yr (N=132; p<0.001)
School (N \approx 1800, New Mexico)	0.88/yr



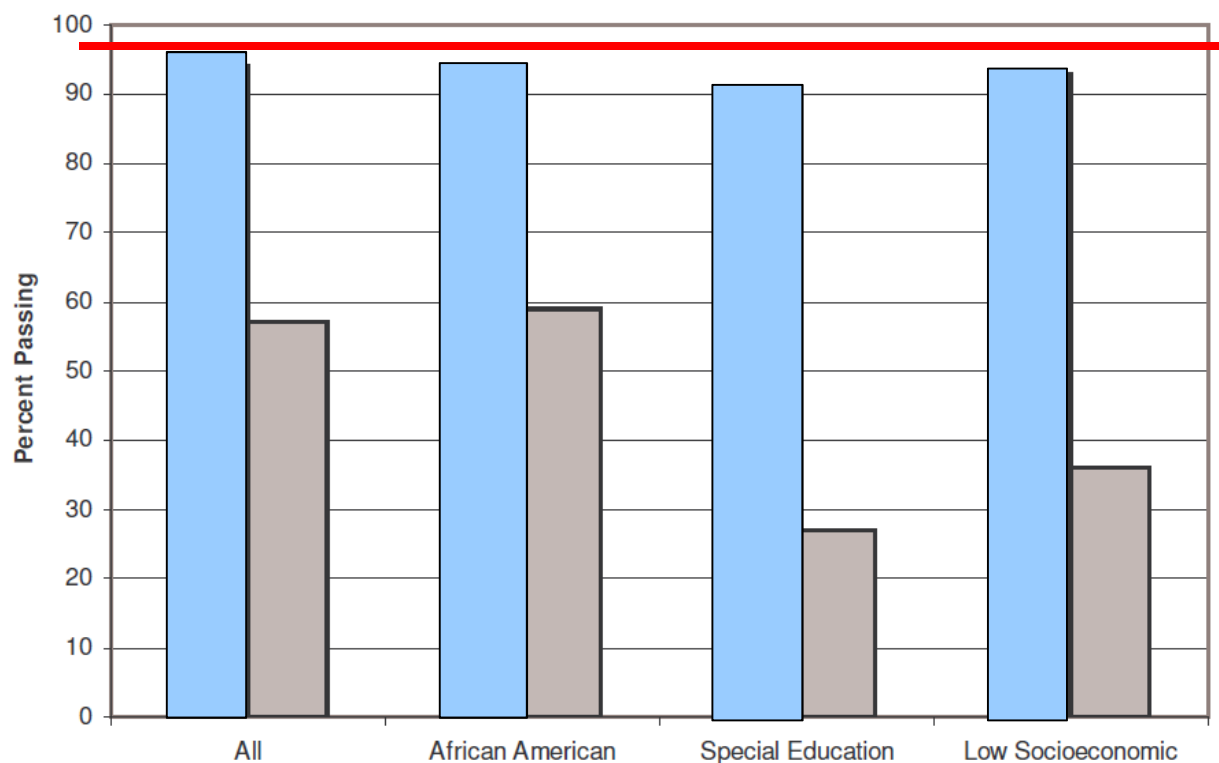
What California data really means

(data from Nevada and New Mexico are consistent with this)



Georgia High School Graduation Test, Math

GHSMT Mathematics Results (Experimental Vs. Control)

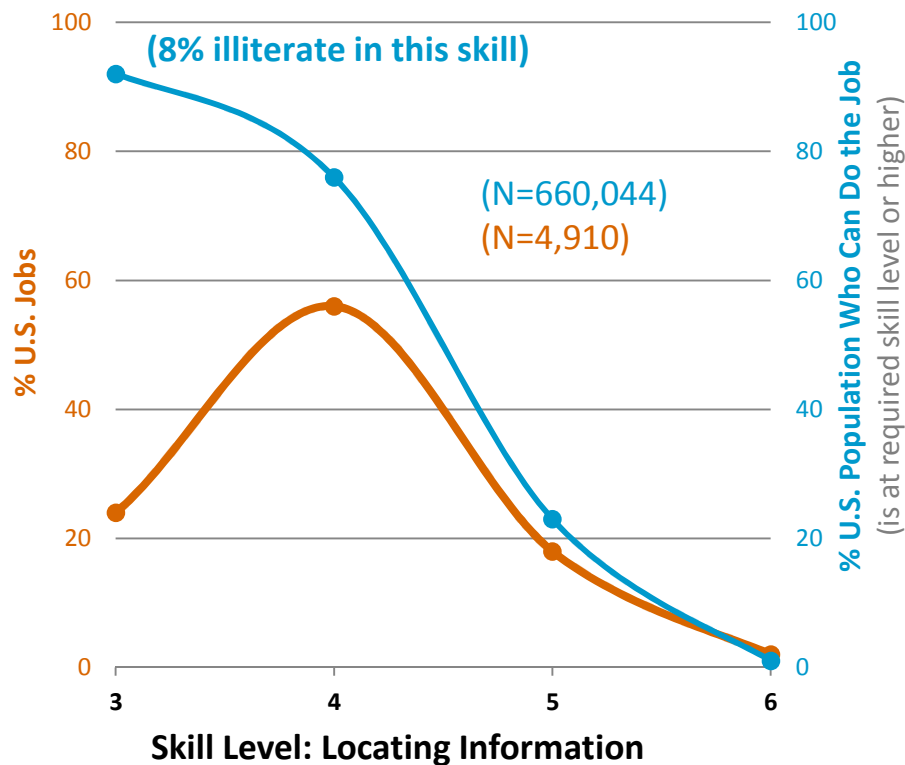


White, Statewide

Used Keytrain®

Did Not Use Keytrain®

Understanding charts & diagrams ("Locating Information") is actually a bigger problem than Applied Math



There is not enough "excess" high skill population for employers to demand this skill at high levels PLUS any other criterion (e.g., individual lives in their state, has a particular degree, is a U.S. citizen, has prior experience).

National deficiency in Locating Information is a major contributor to the “STEM crisis”

O*Net Code	Title	Clusters
17-2011.00	Aerospace Engineers	Science, Technology, Engineering & Mathematics
17-1011.00	Architects, Except Landscape and Naval	Architecture & Construction
13-1051.00	Cost Estimators	Arch / Construction; Bus / Mgmt / Admin; Sci / Tech / Eng / Math
51-4032.00	Drilling and Boring Machine Tool Setters, ...	Manufacturing
17-2199.00	Engineers, All Other	
11-9061.00	Funeral Directors	Human Services
11-1021.00	General and Operations Managers	Bus / Mgmt / Admin; Gov / Public Admin
17-1012.00	Landscape Architects	Architecture & Construction
19-2032.00	Materials Scientists	Science, Technology, Engineering & Mathematics
19-2012.00	Physicists	Health Science; Sci / Tech / Eng / Math
13-1021.00	Purchasing Agents and Buyers, Farm Pro...	Agriculture, Food & Natural Resources
27-3042.00	Technical Writers	Arts / AV Tech / Comm; Bus / Mgmt / Admin

The “Workplace Math” View of the World is So Different

CONVENTIONAL WISDOM

- You need a lot of math content/courses if you want a good job.
- Taking math courses gives you the ability to apply math.
- School degrees are a good first cut to predict who will perform on the job.

WORKPLACE SKILLS VIEW

- You need to be able to **apply** math if you want a good job, but only at the 6th grade level.*Some exceptions apply
- Pre- and post-testing of even college algebra class show zero gains in applied math skill, because content was taught but critical thinking was not (NONM data).
- School degrees predict 1-10% of work performance variation. Cognitive skills tests are 5-25 times more effective as a first screen.

The Inability to Code Real-World Situations into Math (to “Apply” Math) Occurs Even in Graduates of College Programs DESIGNED to Teach Applied Math – (e.g., Financial Engineering/Computational Finance)



Proof: Employers are desperate to hire in this field

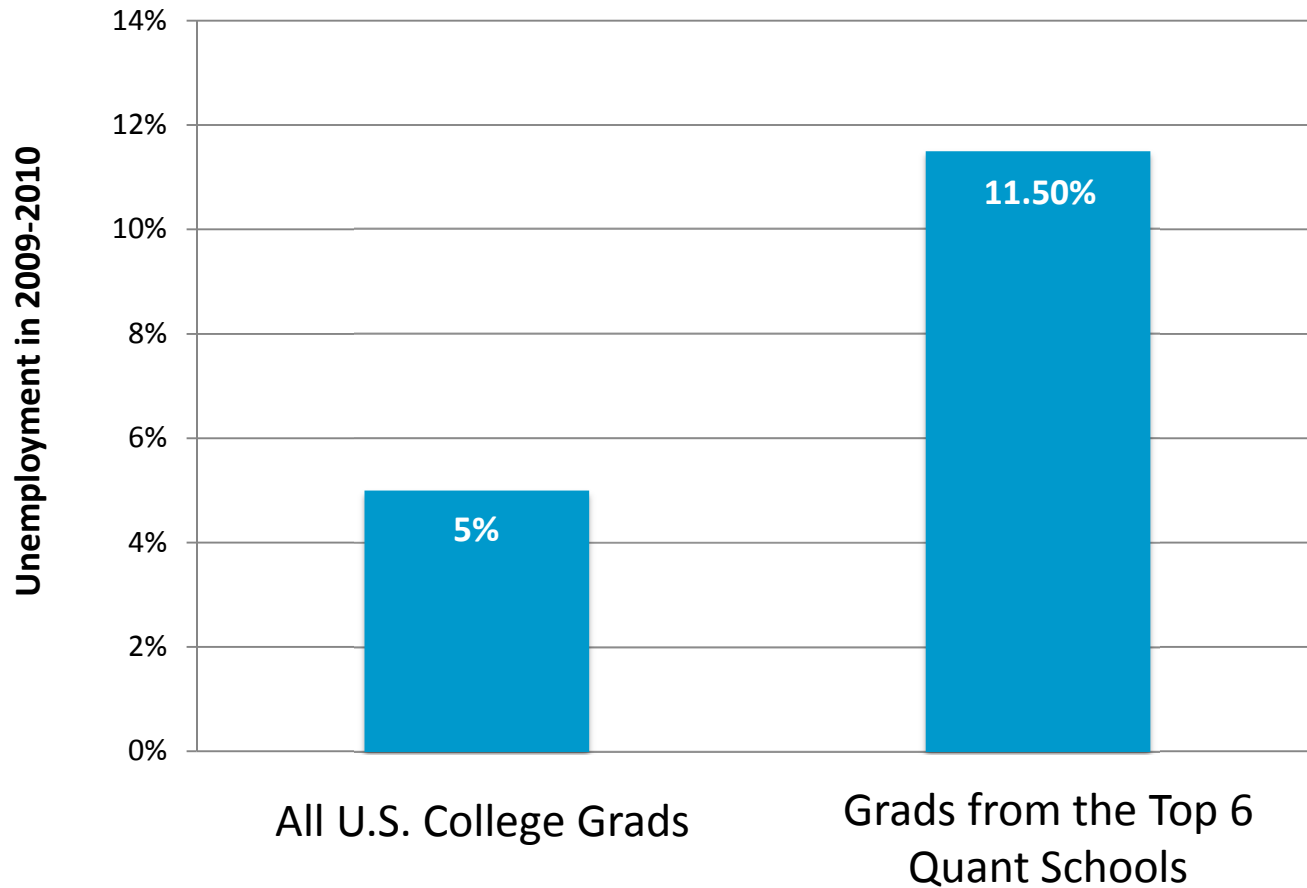
Junior Quantitative Analyst, PhD Machine Learning or Signal Processing – Investment Bank – NYC, \$250k
PhD from a well-regarded university, in Physics, Computer Science, Machine Learning, Signal Processing, Computer Vision, Statistics, Econometrics, Operations Research

PhD Quant Analyst (High-Performance Computing) – Fixed Income Research – NYC, \$250k
PhD in a Quantitative/Scientific subject. PhD from a top-tier university.

Quant Developer/ Algo Developer – Algorithmic Trading Firm – Chicago, \$175-250k
To qualify for this position, you will have a Bachelors, Masters or PhD in Computer Science etc. from a red brick university with a high GPA.

From one week's job postings in Quantjobs.com

But they consider college graduates
in this field unemployable



(Berkeley, CMU, Columbia, Cornell, NYU, Stanford)

How Can This Be?

“All over the world, it has become fashionable for Universities and Colleges to offer Masters degree programs in quantitative finance or financial engineering (FE), a code word meaning the solution of the Black-Scholes option pricing differential equation in as many ways as possible.

“Unless the [academic] field re-invents itself pronto and starts becoming relevant to what people actually do out there, graduates with newly minted financial engineering degrees hoping to see a decent return on their own or their parents’ sizable investment will continue to be sorely disappointed by their actual career prospects, and will keep wondering where in God’s name they went wrong.”

-Sylvain Raynes

Founding Principal of R&R Consulting, a structured credit metrics consultancy

Better to teach students to see the world in terms of math, so they can solve 6th grade math problems and hold a job, than to never teach them this skill, and be unemployable all the way through a graduate degree.

**In New Mexico, We Are Moving Employers
Away From “Degree-Based Hiring” Towards
“Skill-Based Hiring.”**

New Mexico Job Order Print Document

Job Information:

Job Order: 260354

Print Date: 4/22/2013 3:03:38 PM

Job Title: **Teacher Assistant/Artesia**

Occupational Code: **25904100 Teacher Assistants**

Industry Code: Confidential Information

Type of Job: **Regular**

Job Time Type: **Full Time (30 Hours or More)**

Duration: **Over 150 Days**

Special Job Category:

Green Job: **Not Specified**

Job Created from ARRA (Stimulus): **No**

Employer Name: **Not Available**

Job Duties and Skills:

Description:

Veterans Preference: To ensure compliance with the Jobs for Veterans Act, this job posting will be available only to veterans for the first 24 hours from 4/15/13 until 4/16/13. After this period, the job will be released to all job seekers.

Perform duties that are instructional in nature or deliver direct services to students or parents. Serve in a position for which a teacher or another professional has ultimate responsibility for the design and implementation of educational programs and services. Must have 6 months early childhood related work experience. Must obtain Child Development Associate credential/or State Certificate within three and a half years from date of hire. possess excellent oral and written English communication skills. Must have a high school diploma or GED. APPLY AT CARLSBAD WORKFORCE CONNECTION-VJFSC/NM/LV9182

WorkKeys Preferred:

RI- 4

AM- 4

LI- 3



Teacher Assistant in Artesia = Workkeys® Reading Level 4, Applied Math 4, Locating Info Level 3

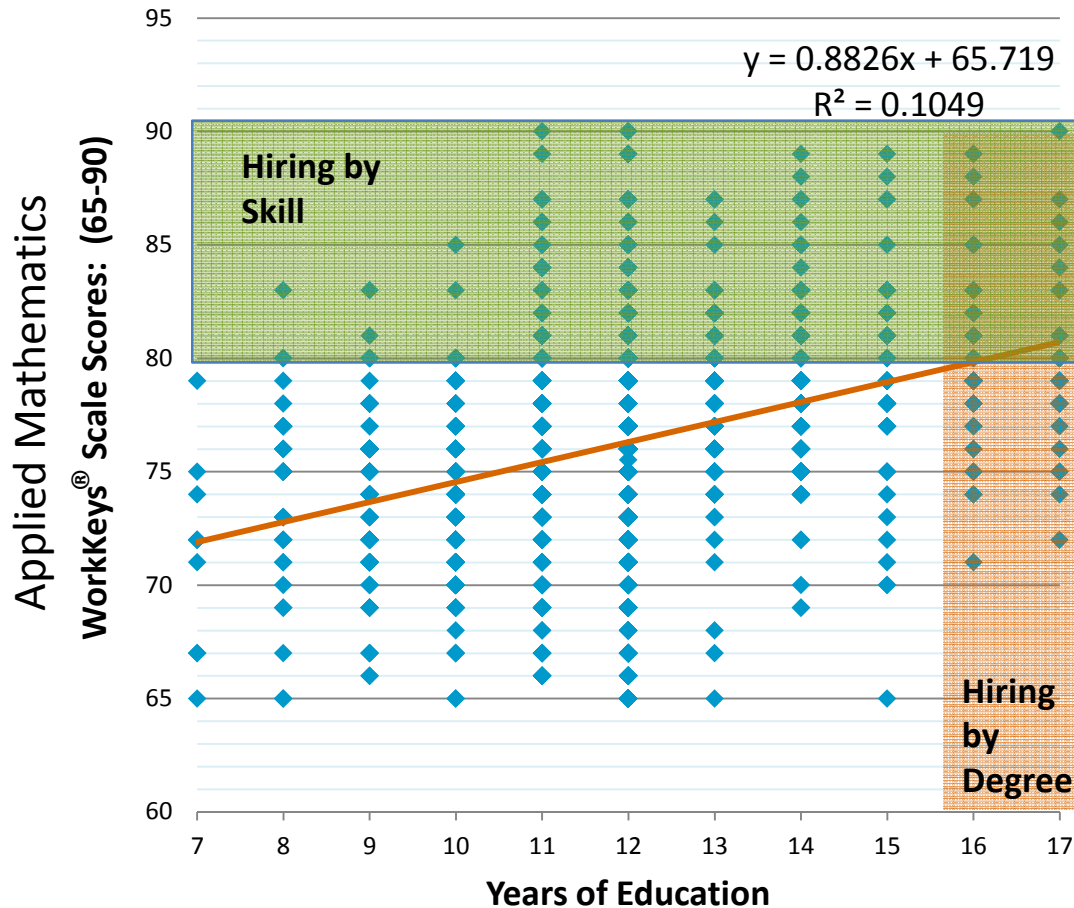


I need someone who is a
Level 5 in Listening, a Level
4 in Applied Math.

That's me!!! I have those
scores!



Only 10% of an individual's ability to apply math, can be explained by years in school



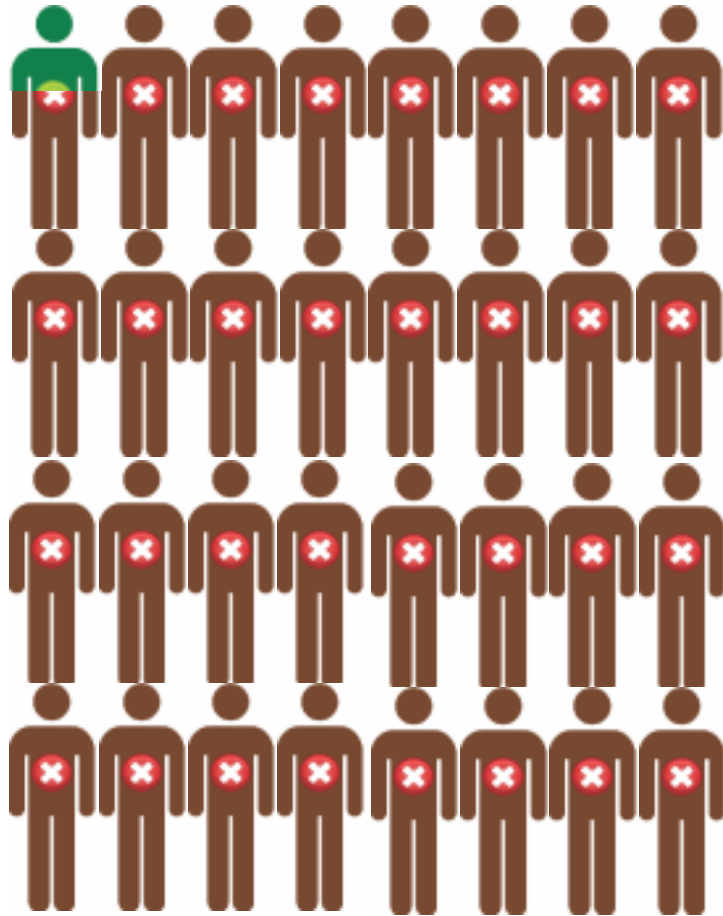
Correlation= .32
N=1809

Data from NMDWS; analysis by Tom Kilijanek

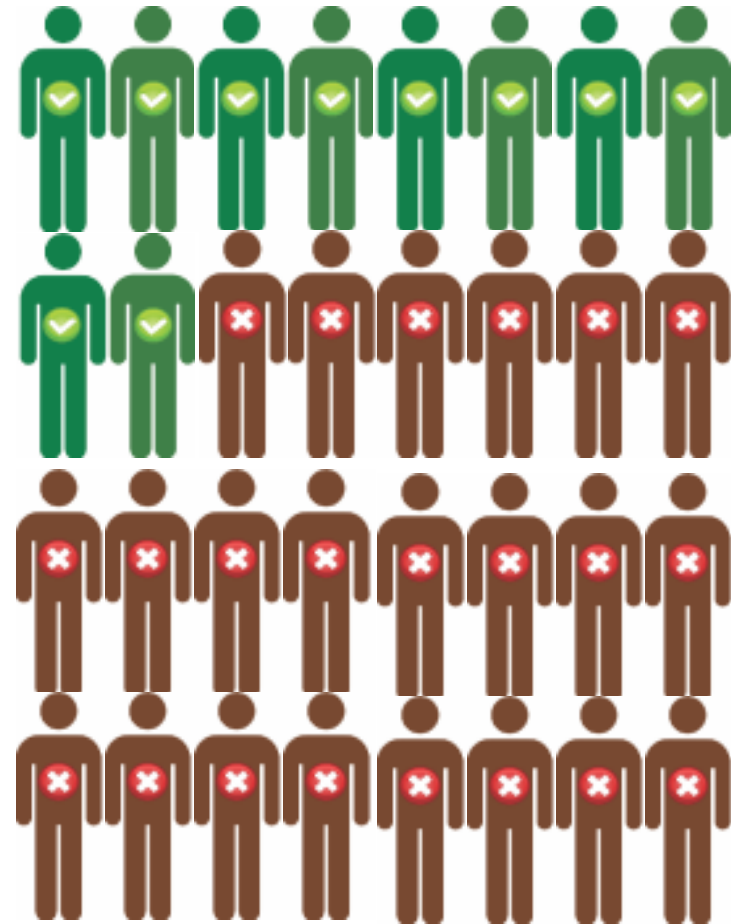
WorkKeys is a registered trademark of ACT, Inc. For more information please visit <http://www.act.org/products/workforce-act-workkeys/>

Impact on Job Placement

For jobs requiring a college degree:



1% of unemployed New Mexican youth eligible if by Degree



33% of unemployed New Mexican youth eligible if by Skill