Assessing Conceptual Understanding of Algebra

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Goal

Develop a good measure of students' knowledge of Algebra 1 concepts

Background

Proficiency in algebra is critical to academic, economic, and life success (Adelman, 2006; NMAP, 2008).

Developing conceptual knowledge (CK) is critical; understanding of key concepts such as equivalence and variable is essential to success in algebra (Knuth et al., 2006). However, existing assessments **rarely assess conceptual knowledge**.

Among **first efforts to provide reliable and valid measure**, a process heavily emphasized by AERA/APA/NCME (1999) testing standards.

Method

PARTICIPANTS: 77 students from 4 Algebra I classrooms (*M* age = 14 yrs; 50% female; 16% ethnic minorities)

MEASURES

- **New Alg. CK assessment** given at end of school year
- **Prev. Alg. CK measure** given at beg. of school year
- **Prev. Alg. I course grades** from 1st semester
- **Prev. year state test performance category**

Results

EVIDENCE OF RELIABILITY

Internal consistency

Cronbach's Alpha = .66

EVIDENCE OF VALIDITY

Criterion validity

- Accuracy was significantly correlated with prev. course grades, r (75) = .42
- Students who scored in the 'advanced' range (n = 42) on the prev. year state test outperformed those in the 'proficient' range (n = 30), (M = 70% vs. 47% correct, t (70) = 4.5, p < .001).

Construct validity

- Accuracy was significantly correlated with the prev. alg. CK measure, r (72) = .54
- Students in advanced level of course outperformed those in regular level (M = 88% vs. 50% correct, t (64.4) = 11.8, p < .001).

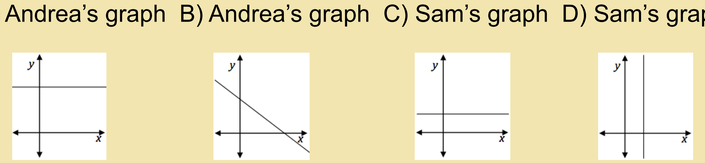
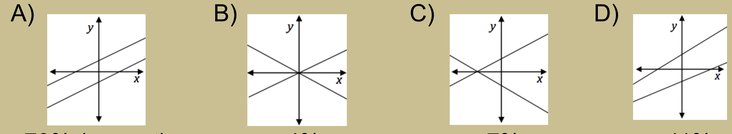
Conclusions

Algebra 1 students still have room for growth in their knowledge of core concepts.

Our assessment demonstrated acceptable reliability (for group comparisons) and good validity.

Evidence of valid and reliable measures is important for evaluating the impact of interventions and developing theories of algebra learning.

New Conceptual Knowledge (CK) Assessment

Topic	Number of Items	Example Item and Response Rates
Solving Linear Equations	2	Look at this pair of equations. Without solving the equations, decide if these equations are equivalent (have the same answer). $34 = 8(x+1) + 6(x+1)$ $34 = 14(x+1)$ A) YES (same answer) 47% (correct) B) NO (different answer) 38% C) CAN'T TELL without doing the math 13%
Graphing and Writing Linear Equations	2	Sam drew the line $y = 6$. Andrea drew the line $x = 15$. Which of the following graphs correctly shows the line Sam or Andrea drew? A) Andrea's graph B) Andrea's graph C) Sam's graph D) Sam's graph  21% 14% 60% (correct) 5%
Systems of Equations	2	Which of the following graphs could represent a system of equations with no solution?  A) 79% (correct) B) 4% C) 7% D) 11%
Polynomials and Factoring	2	Which of the following expressions is NOT equivalent to $(x + 4)(3x + 2)$? A) $(3x + 2)(x) + (3x + 2)(4)$ 12% B) $x(3x) + 2(4)(3x) + 4(2)$ 58% (correct) C) $x(3x) + x(2) + 4(3x) + 4(2)$ 13% D) $(x + 4)(3x) + (x + 4)(2)$ 13%
Quadratic Equations	2	Choose the definition that best describes the solution to the quadratic equation $x^2 - ax - b = 0$. A) The x-coordinate(s) of the point(s) where the graphs of $y = x^2$ and $y = ax^2 + b$ intersect. 18% B) The x-coordinate(s) of the point(s) where the graphs of $y = x^2 - b$ and $y = ax$ intersect. 18% C) The ordered pair(s) where the graphs of $y = x^2$ and $y = ax + b$ intersect. 5% D) Both a and b 36% (correct) E) Both b and c 12%

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