Hands-On Equations® Research, Interim Results: Study 33c, July 7, 2007
The Effect of Hands on Equations on the Learning of Algebra
by Title I Inner City Students in the 5th Grade: 194 Students (Short Report)

Hands-On Equations (HOE), developed by Dr. Henry Borenson, uses numbered-cubes to represent the constants, and blue pawns to represent the variable x. It also uses a scale representation on which the students "set up" the equation. The students then proceed to use "legal moves," which are the mathematical counterpart of the abstract algebraic methods which are used to solve these linear equations. The system thus makes abstract linear equations visual and understandable, and further provides students with the means of solution through a kinesthetic approach which makes sense to them.

The program is unique in that the abstract knowledge base needed by students to solve these equations is transformed into an easily understood and manageable set of verbal, visual and kinesthetic responses using manipulatives. The program teaches algebraic principles which students in grade 3 to 8 can apply in any sequence desired to solve the given equation. Hence, the students using Hands on Equations need not memorize a series of steps to solve an equation, as is the case in more traditional instruction. Rather they feel empowered to use their thinking and understanding of basic principles to solve the problem at hand.

The research study uses a Multi-Site Replications Design and a Meta Analysis procedure to study the effect of the HOE program on many groups of students with different characteristics (regular education, special ed., gifted, elementary, middle-school, high school, etc). All of these groups of students will be studied separately. Presently we have data on more than 50 classrooms,

This particular study (#33c) was designed to measure the effects of the first six lessons of the HOE program on the learning of algebra by 5th grade inner-city Title one students whose teachers were taught HOE by Borenson and Associates, and their level of retention three weeks later.

This study is a Meta Analysis of 7 separate studies, each involving a separate classroom of 5th grade inner city Title 1 students in a large school district on the west coast whose teachers learned HOE procedures early in February 2007. They began teaching HOE to their students almost immediately (pre-test given to individual classrooms between February 12 and February 20, 2007). The teaching of HOE through Lesson 6 concluded for individual classroom on or about February 21 and March 4, at which time the post-test for Lesson #6 was administered. The retention test was administered three weeks after the post-test (March 15- 33). The students were allowed to use the game pieces on both the post-test and the retention test. They were allotted 15 minutes to take each of the tests. No instruction in the program took place between the post-test and the three-week retention test.

RESULTS

Seven classrooms were included in this study (combined N = 194). Each classroom's data was analyzed independently to provide each teacher with feedback about their and their students' performance. T-tests were conducted between the means of the pre-test and the post-test after lesson 6, and between the pre-test and the retention test. These data then were combined into a single Meta Analysis for all seven classrooms. The effect sizes between the pre-test and post-test and between the pre-test and the retention test were large and highly significant. The gain between the pre-test mean (2.57) and the post-test mean (5.08) produced a t-value of 22.26 and the gain between the pre-test (2.57) and the retention test (4.76) produced a t-value of 17.94.

CONCLUSIONS:

After being provided with the first six lessons of Hands-On Equations, the combined group of 194 inner-city 5th grade Title 1 students gained a knowledge of algebra to the point that they produced gains between the pre-test and the post-test that were large and significant and that they remembered what they learned sufficiently to produce gains between the pre-test and the retention test that were large and significant*.

In earlier studies (# 23), (#25b), (#33b), (#35) and Barclay (1992) we have sufficient data to conclude that HOE teaching procedures produce large and significant gains in algebra knowledge for students in the regular 6th grade classroom, for 2nd grade gifted students, and for at-risk students in grades 9 – 12, With this study we have additional data that 5th grade inner-city Title 1 students learn and retain algebra knowledge through HOE procedures.

* In percentage terms, the mean increased from 42.8% on the pre-test to 84.7% on the post-test and 79.3% on the retention test. Copies of the tests are shown below.

Pre-Test Questions	**Three-Week Retention Test**
1. $2x = 8$	**1. $2x = 12$**
2. $x + 3 = 8$	**2. $x + 3 = 10$**
3. $2x + 1 = 13$	**3. $2x + 1 = 9$**
4. $3x = x + 12$	**4. $3x = x + 10$**
5. $4x + 3 = 3x + 6$	**5. $4x + 3 = 3x + 10$**
6. $2(2x + 1) = 2x + 6$	**6. $2(2x + 2) = 2x + 18$**
Post-test after Lesson 6	
1. $2x = 10$	
2. $x + 3 = 8$	
3. $2x + 2 = 10$	
4. $3x = x + 4$	
5. $4x + 3 = 3x + 9$	
6. $2(2x + 1) = 2x + 8$	

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