Hands-On Equations Research, Interim Results March 18, 2007
The Effect of Hands on Equations on the Learning of Algebra
by Regular Education 6th Graders

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 studies 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 in our study of the effects of the HOE program on Multiple Student Characteristics.

This particular study was designed to measure the effects of the first six lessons of the HOE program on the learning of algebra of 6th graders in a regular education program. The teachers of these children had been trained in the HOE teaching system by Borenson and Associates, Inc. in the fall of 2006. This training consisted of attendance at a one-day workshop with titled "Making Algebra Child's Play." The teaching effects of using HOE on the students of these teachers were measured by determining if the difference between the pre-test[1] and post-test scores were large enough to have occurred for reasons other than chance. The students were permitted to use their game pieces for the post-test.

RESULTS

Three classrooms (two in Pennsylvania and one in Ohio) were involved in this study (combined N of 79). Each classroom was analyzed alone, then two classrooms were combined (N of 52) and this combination analyzed, then 3 classrooms were combined and analyzed. This "meta analysis" was done in accordance with the multiple replication methodology of these studies (plus the data came in at different times).

Each classroom analysis produced pre to post gains that were very large and highly significant, (Clayton, t = 10.45; Sherman, t = 13.80; Sleet, t = 17.82). The combination of the first two (Note the order was a function of time of arrival to be analyzed) produced a combined t = 17. 32. The combination of the three teachers data (n= 79) produced a t score of 22.63. All t values are highly significant and as the N grows through combining classrooms the effect size increases. One could safely conclude that the effect of the HOE program, when taught by teachers trained in the use of the program, produces significant learning increases[2] for students in the regular 6th grade education program.

1. The pre and post tests are attached
2. The combined pre-test average for all three groups was 41%; the combined post-test average for all three groups was 95.6%

Report prepared by Larry W. Barber Ph.D., March 18, 2007

PRE-TEST QUESTIONS

1. $2x = 8$

2. $x + 3 = 7$

3. $2x + 2 = 8$

4. $3x = x + 6$

5. $4x + 3 = 3x + 6$

6. $2(2x + 1) = 2x + 6$

7. $x + 3x = x + x + 10$

8. $4x - 3x + 9 = 2x + 6$

POST-TEST QUESTIONS

1. $2x = 10$

2. $x + 3 = 8$

3. $2x + 2 = 10$

4. $3x = x + 4$

5. $4x + 3 = 3x + 9$

6. $2(2x + 1) = 2x + 8$

7. $x + 3x = x + x + 18$

8. $4x - 3x + 5 = 2x + 3$