Four-Year-Old Jack Doing Equivalent Fractions

By Dr. Aditya Nagrath PhD

Abstract

We examine the effectiveness of the Elephant Learning Platform for teaching mathematics. From 2017-2022, Elephant Learning has had over 140,000 students come through their proprietary math learning system. We have gone through the case study data already published on the website to provide a cross sectional examination of the data.

In this case study, we examine a four-year-old boy named Jack. Young students tend to perform better than older students within Elephant Learning because they do not know they are working on things that are more advanced than their age. In return, they never develop mathematics anxiety because as they go through class, they understand the teacher based on the standards and experiences they have within Elephant Learning. Jack, over the course of six months, gained 3.8 years in Elephant Age™ and at age 4 has understanding of materials intended for 8.79 years of age such as Multiplication and Division.

Methodologies

Students were provided with access to Elephant Learning's mathematics system via their parents. The students then used Elephant Learning naturally over different periods of time, for varying time durations and length of trial. Trials were administered by the parent or were self driven by the student. Coaching was provided for the parents to help students overcome any struggles.

Coaching consists of teacher training videos and coaching around mathematics anxiety. Teacher training videos are presented at a subject level based on the student's elephant age and open subjects.

Elephant Learning's system asks parents upon entry to confirm the placement exam for the student. The default settings conduct a placement within the Elephant Learning system using an examination for students older than five years of age. This placement exam is based on an examination of activities presented to the student and is intended to start approximately 2 years behind the student's current level. Students are presented puzzles that show proficiency in common core and state standards for conceptual mathematics. Elephant Learning's proprietary system presents puzzles in an optimal order for facilitating a student's conceptual understanding.

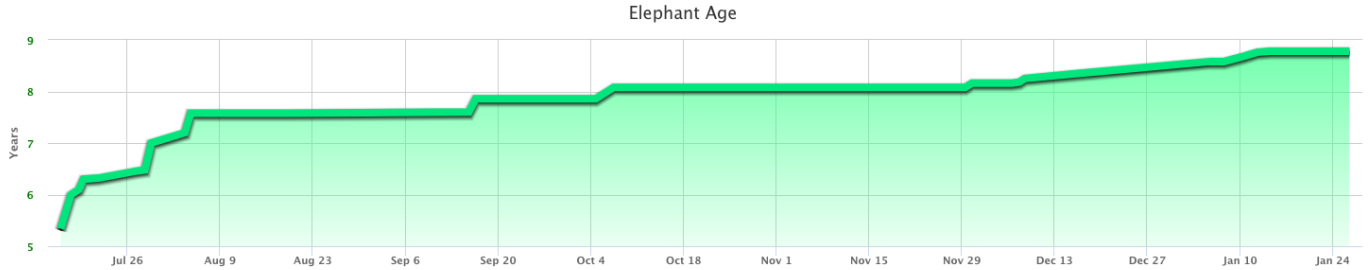
Progress is measured by the Elephant Age™ which represents, approximately, the average age that a student outside of the system is doing the same mathematics as a student within our system. The Elephant Age™ is the average of the ages assigned to recently passed milestones. The milestones are associated with line item standards, like common core, and the ages assigned to the milestones were calculated based on those standards.

We have had numerous parents come back and leave testimonials that their young students (ages 5 and under) have reached and are accomplishing in subjects as advanced as division and fractions, decimals, and percentages. We created an aggregate designed to fetch students that were younger than age 6 that worked within the introduction to fractions subject for a meaningful amount of time. We then chose a student from anonymous data. The aggregate required at least 8 weeks worth of work within the system. 1,379 students matched the given query. We decided to choose a student with 20 weeks of work as within the window of our results there were several. We also used the time in the subject as methodology for choice as the minimum display for time within the subject on the window of our results was 30 seconds. Because we were looking for a student that had made meaningful progress in the subject we were choosing a student with at least 300 seconds (5 minutes) within the subject. Jack had displayed 654 seconds (~10 minutes).

Initial Placement

Students are placed within counting to 5 (Beginning Counting) at age 3 or counting to 10 (Advanced Counting) at age 4 years of age without need for placement exam. An older student that is not performing will easily fail back to counting to five and so no placement exam is necessary. Both 3 and 4 year olds also receive Beginning Comparisons (language around more or less). Jack entered our system at age 4. At the time of the analysis, the student is 5 years of age. The student used the system between July 2021 and January 2022 and has a birth date in July, 2017.

Name: Jack **Age:** 5.0 yrs **SEA:** 5.00 yrs **EA:** 8.78 yrs **Diff:** 3.78 yrs



Weekly Data

Week 1

Beginning Comparison

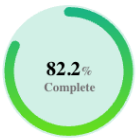
Advanced Counting

The Tweens

Addition and Subtraction to 10

Week 56

Multiplication and Division Using Groups



Multiplication and Division Using Grids

Counting to 100 on the Number Line

Introduction to Equivalent Fractions

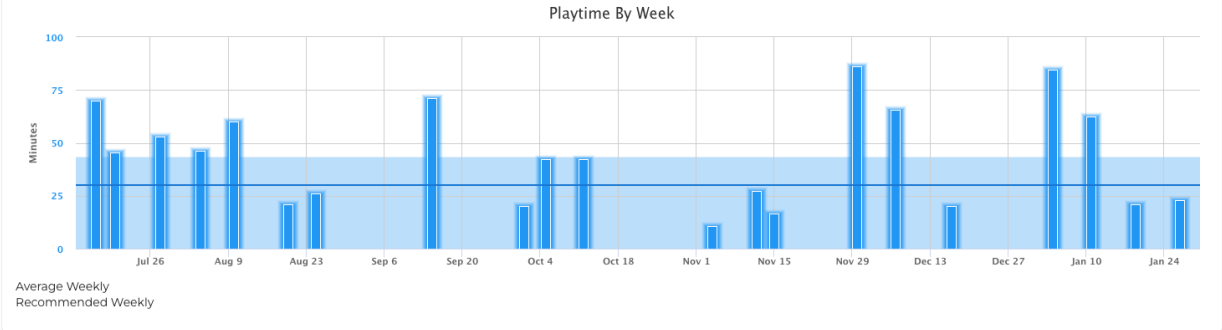
Division

Estimate Numbers to 200

Logic Puzzles with Small Numbers

Find My Number

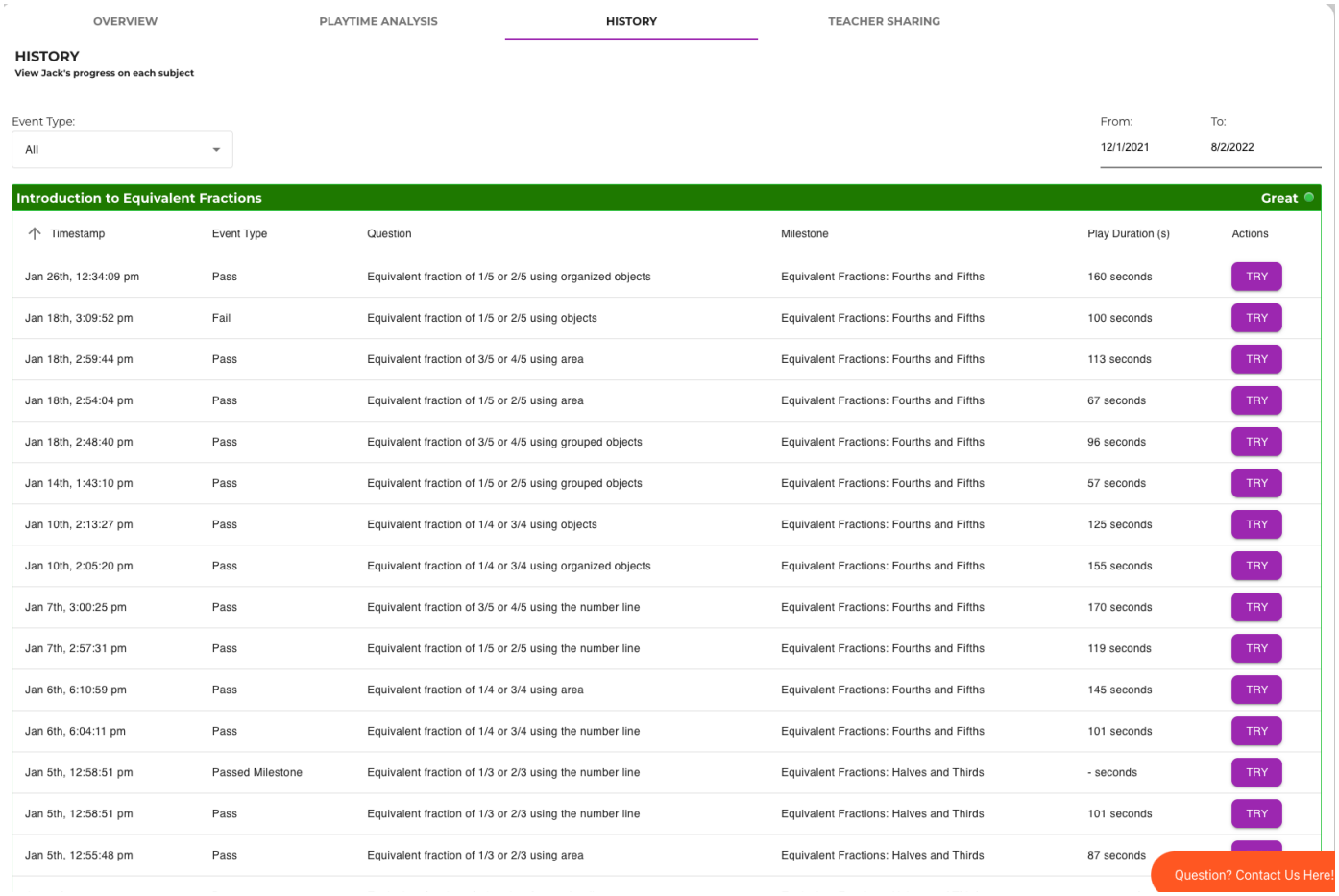
Numbers



Average Weekly	43.58 min	Max Weekly	86.07 min
60 min		60 min	
Last Week	20.85 min	This Week	23.02 min
60 min		60 min	

The system based on historical data gathered on the student is showing the student used the system an average of 43 minutes per week. Also shown are the subjects that the student worked on during week 1 and current completion status (all subjects are now showing completed) along with the subjects that are currently open and current week number. The account was cancelled in February of 2022 and so usage was determined based on the history screen shown below.

The change in Elephant Age™ is 3.78 years with completing elephant age being 8.78 years of age which approximately matches the average age the subjects that are currently open are taught within the classroom.



OVERVIEW | PLAYTIME ANALYSIS | HISTORY | TEACHER SHARING

HISTORY
View Jack's progress on each subject

Event Type: All

From: 12/1/2021 To: 8/2/2022

Introduction to Equivalent Fractions — Great

Timestamp	Event Type	Question	Milestone	Play Duration (s)	Actions
Jan 26th, 12:34:09 pm	Pass	Equivalent fraction of 1/5 or 2/5 using organized objects	Equivalent Fractions: Fourths and Fifths	160 seconds	TRY
Jan 18th, 3:09:52 pm	Fail	Equivalent fraction of 1/5 or 2/5 using objects	Equivalent Fractions: Fourths and Fifths	100 seconds	TRY
Jan 18th, 2:59:44 pm	Pass	Equivalent fraction of 3/5 or 4/5 using area	Equivalent Fractions: Fourths and Fifths	113 seconds	TRY
Jan 18th, 2:54:04 pm	Pass	Equivalent fraction of 1/5 or 2/5 using area	Equivalent Fractions: Fourths and Fifths	67 seconds	TRY
Jan 18th, 2:48:40 pm	Pass	Equivalent fraction of 3/5 or 4/5 using grouped objects	Equivalent Fractions: Fourths and Fifths	96 seconds	TRY
Jan 14th, 1:43:10 pm	Pass	Equivalent fraction of 1/5 or 2/5 using grouped objects	Equivalent Fractions: Fourths and Fifths	57 seconds	TRY
Jan 10th, 2:13:27 pm	Pass	Equivalent fraction of 1/4 or 3/4 using objects	Equivalent Fractions: Fourths and Fifths	125 seconds	TRY
Jan 10th, 2:05:20 pm	Pass	Equivalent fraction of 1/4 or 3/4 using organized objects	Equivalent Fractions: Fourths and Fifths	155 seconds	TRY
Jan 7th, 3:00:25 pm	Pass	Equivalent fraction of 3/5 or 4/5 using the number line	Equivalent Fractions: Fourths and Fifths	170 seconds	TRY
Jan 7th, 2:57:31 pm	Pass	Equivalent fraction of 1/5 or 2/5 using the number line	Equivalent Fractions: Fourths and Fifths	119 seconds	TRY
Jan 6th, 6:10:59 pm	Pass	Equivalent fraction of 1/4 or 3/4 using area	Equivalent Fractions: Fourths and Fifths	145 seconds	TRY
Jan 6th, 6:04:11 pm	Pass	Equivalent fraction of 1/4 or 3/4 using the number line	Equivalent Fractions: Fourths and Fifths	101 seconds	TRY
Jan 5th, 12:58:51 pm	Passed Milestone	Equivalent fraction of 1/3 or 2/3 using the number line	Equivalent Fractions: Halves and Thirds	- seconds	TRY
Jan 5th, 12:58:51 pm	Pass	Equivalent fraction of 1/3 or 2/3 using the number line	Equivalent Fractions: Halves and Thirds	101 seconds	TRY
Jan 5th, 12:55:48 pm	Pass	Equivalent fraction of 1/3 or 2/3 using area	Equivalent Fractions: Halves and Thirds	87 seconds	

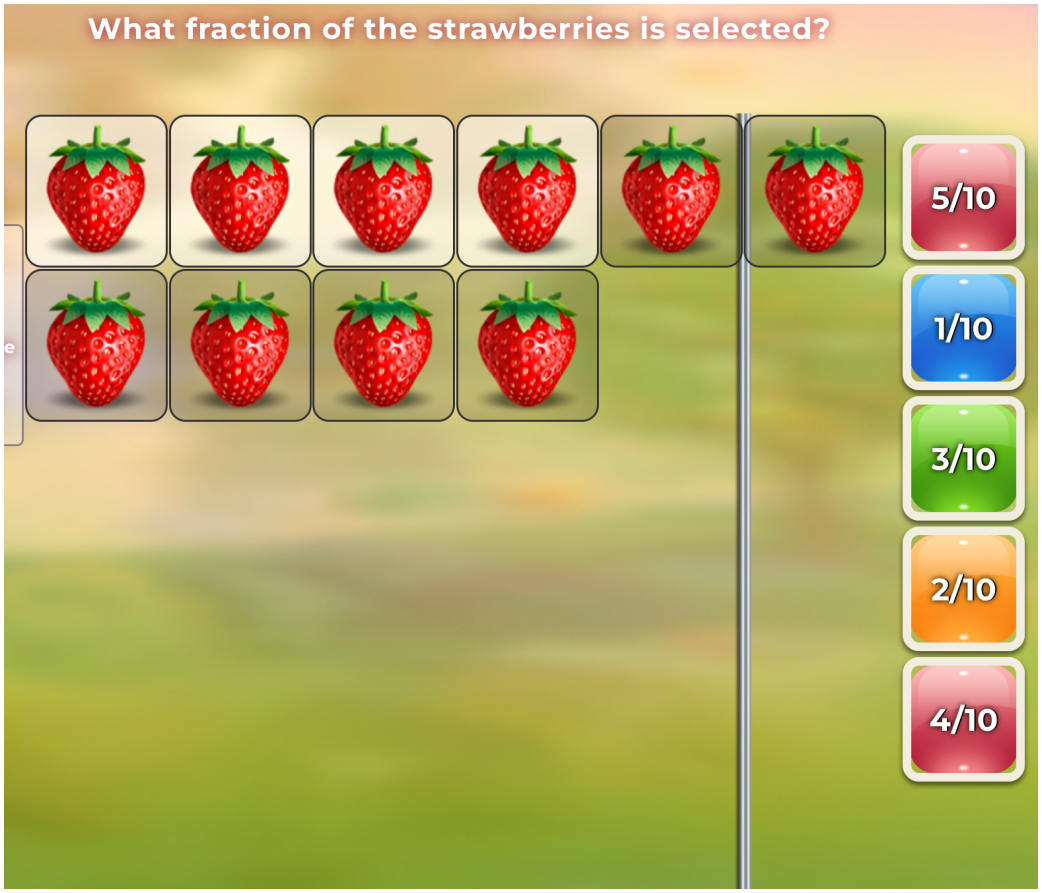
Question? Contact Us Here!

Here is a screenshot of the most recent history of the student. One can see they passed the milestone "Equivalent fraction of 1/3 or 2/3 using the number line" which corresponds to CCSS.MATH.CONTENT.3.NF.A.3.B available in description here: http://www.corestandards.org/Math/Content/3/NF/A/3/b/

An example question, shown as passed within the data is "Equivalent fractions ⅕ or ⅖ using grouped objects" is presented to show student demonstrating understanding. The question starts asking the student to identify either ⅕ or ⅖ of a group of objects. 10 objects are shown,

and we randomly choose between 6 or 7 items per row (with an indication of where the fifth item is so students may quickly identify the number of objects). Shown is the question to select ⅖ of the strawberries. Afterwards, the system indicates that there are different “names” that can be used for the same fraction (the idea of “equivalent fractions”), the student is then asked to identify another fraction that would identify the same selected quantity (out of 10).


Select 2/5 of the strawberries
Remove Disabled Parent Mode
Parent Mode Does Not Alter Student's Score
OK


What fraction of the strawberries is selected?
5/10
1/10
3/10
2/10
4/10

Therefore, the student is demonstrating understanding of ⅖ of ⅕ in order to correctly identify the amount, and is building an understanding that another way to state the same ratio over 10 (known colloquially as an equivalent fraction). Student's birthday is shown within the system as July 2017, and so at the time of answering the question (Jan 14 2022), the student was ~4.5 years of age.

Conclusions

These sorts of results fly in the face of psychological research indicating that such materials may not be developmentally appropriate. Having said that research into mathematics education shows mounting evidence that the idea of developmentally appropriate is incorrect as applied to understanding mathematics. Notably the works of D.H. Clements and J. Sarama have shown and cited research indicating that children as young as four exhibit concepts as advanced as division during play. The End Notes provides a body of work that supports this conclusion.

Tools such as Elephant Learning that conceptually develop students' understanding in a systematic method can allow students to understand what we currently consider as extremely advanced topics at a young age. In turn this allows us to do more advanced projects and develop more advanced ideas at ages when students tend to be more naturally curious.

End Notes

1 D.H. Clements and J. Sarama, Learning and Teaching Early Math: The Learning Trajectories Approach (New York, NY: Routledge, 2009); D.H. Clements and J. Sarama, Early Childhood Mathematics Education Research: Learning Trajectories for Young Children (New York, NY: Routledge, 2009).

2 K. Denton and J. West, Children's Reading and Mathematics Achievement in Kindergarten and First Grade (Washington, D.C., vol. 2002, 2002).

3 National Mathematics Advisory Panel, Foundations for Success: The Final Report of the National Mathematics Advisory Panel (Washington D.C.: National Research Council, 2008); Mathematics in Early Childhood: Learning Paths Toward Excellence and Equity (Washington, D.C.: National Academy Press, 2009); H.W. Stevenson and R.S. Newman, “Long-term Prediction of Achievement and Attitudes in Mathematics and Reading,” Child Development, 57, 646-659, 1986.

4 G.J. Duncan, C.J. Dowsett, A. Claessens, K. Magnuson, A.C. Huston, P. Klebanov, and C. Japel, “School Readiness and Later Achievement,” Developmental Psychology, 43(6), 1428–1446, 2007; D.C. Farran, C. Aydogan, S.J. Kang, M. Lipsey, Preschool Classroom Environments and the Quantity and Quality of Children's Literacy and Language Behaviors, 2005; M.K. Lerkkanen, H. Rasku-Puttonen, K. Aunola, and J.E. Nurmi, “Mathematical Performance Predicts Progress in Reading Comprehension Among 7-year-olds,” European Journal of Psychology of Education, 20(2), 121-137, 2005.

5 J. Sarama, A. Lange, D.H. Clements, and C.B. Wolfe, “The Impacts of an Early Mathematics Curriculum on Emerging Literacy and Language,” Early Childhood Research Quarterly, 27, 489-502, 2012, doi: 10.1016/j.ecresq.2011.12.002.

6 P.M. Sadler and R.H. Tai, “The Two High-School Pillars Supporting College Science,” Science, 317, 457-458, 2007.

7 A.J. Baroody, The Developmental Bases for Early Childhood Number and Operations Standards, 2004; B.A. Clarke, D.M. Clarke, and J. Cheeseman, “The Mathematical Knowledge and Understanding Young Children Bring to School,” Media Education Research Journal, 18(1), 81-107, 2006; D.H. Clements, S. Swaminathan, M.A.Z. Hannibal, and J. Sarama, “Young Children’s Concepts of Shape,” Journal for Research in Mathematics Education, 30, 192-212, 1999.

8 J. Sarama and D.H. Clements, Early Childhood Mathematics Education Research: Learning Trajectories for Young Children (New York, NY: Routledge, 2009); H.P. Ginsburg, N. Inoue, and K.H. Seo, “Young Children Doing Mathematics: Observations of Everyday Activities,” in J.V. Copley (Ed.), Mathematics in the Early Years (Reston, VA: National Council of Teachers of Mathematics, 1999, 88-89).

9 K.H Seo and H.P. Ginsburg, “What is Developmentally Appropriate in Early Childhood Mathematics Education?” in D.H. Clements, J. Sarama, and A.M. DiBiase (Eds.), Engaging Young Children in Mathematics: Standards for Early Childhood Mathematics Education (Mahwah, NJ: Erlbaum, 2004, 91-104).

10 B. Doig, B. McCrae, and K. Rowe, A Good Start to Numeracy: Effective Numeracy Strategies from Research and Practice in Early Childhood (Canberra ACT, Australia, 2003); S. Thomson, K. Rowe, C. Underwood, and R. Peck, Numeracy in the Early Years: Project Good Start (Camberwell, Victoria, Australia: Australian Council for Educational Research, 2005).

11 C. Rouse, J. Brooks-Gunn, and S. McLanahan, “Introducing the Issue,” The Future of Children, 15, 2005, 5-14.

12 D.H. Clements and J. Sarama, Learning and Teaching Early Math: The Learning Trajectories Approach (New York, NY: Routledge, 2009).

13 C. Aubrey, “Children’s Early Learning of Number in School and Out,” in I. Thompson (Ed.) Teaching and Learning Early Number (Philadelphia, PA: Open University Press, 1997, 20-29).

14 M. Van den Heuvel-Panhuizen, “Realistic Arithmetic/Mathematics Instruction and Tests,” in K.P.E. Gravemeijer, M. Van den Heuvel-Panhuizen & L. Streefland (Eds.), Contexts Free Productions Tests and Geometry in Realistic Mathematics Education (Utrecht, The Netherlands: OW&OC, 1990, 53-78).

15 D.H. Clements and J. Sarama, “Early Childhood Mathematics Intervention,” Science, 333(6045), 2011, 968-970, doi: 10.1126/science.1204537; D.H. Clements, J. Sarama, M.E. Spitler, A.A. Lange, C.B. Wolfe, “Mathematics Learned by Young Children in an Intervention Based on Learning Trajectories: A Large-scale Cluster Randomized Trial,” Journal for Research in Mathematics Education, 42(2), 2011, 127-166.

16 R.C. Pianta, W.S. Barnett, M.R. Burchinal, and K.R. Thornburg, “The Effects of Preschool Education: What We Know, How Public Policy Is or Is Not Aligned with the Evidence Base, and What We Need to Know,” Psychological Science in the Public Interest, 10(2), 2009, 49-88, doi: 10.1177/1529100610381908.

17 J. Sarama and D.H. Clements, Early Childhood Mathematics Education Research: Learning Trajectories for Young Children (New York, NY: Routledge, 2009); D.H. Clements and J. Sarama, “Early Childhood Mathematics Intervention,” Science, 333(6045), 2011, 968-970, doi: 10.1126/science.1204537.

18 B. Wright, “What Number Knowledge Is Possessed by Children Beginning the Kindergarten Year of School?” Mathematics Education Research Journal, 3(1), 1991, 1-16.

19 D.H. Clements, & J. Sarama, Learning and Teaching Early Math: The Learning Trajectories Approach (New York, NY: Routledge, 2009); J. Sarama, and D.H. Clements, Early Childhood Mathematics Education Research: Learning Trajectories for Young Children (New York, NY: Routledge, 2009).

20 D.H. Clements and J. Sarama, “Early Childhood Mathematics Intervention,” Science, 333(6045), 2011, 968-970; D.H. Clements and J. Sarama, “Rethinking Early Mathematics: What Is Research-based Curriculum for Young Children?” in L.D. English & J.T. Mulliga (Eds.), Reconceptualizing Early Mathematics Learning, 2013, 121-147; D.H. Clements, J. Sarama, M.E. Spitler, A.A. Lange, "Longitudinal Evaluation of a Scale-up Model for Teaching Mathematics with Trajectories and Technologies: Persistence of Effects in the Third Year,” American Education Research Journal, August 2013, vol. 50 no. 4, 812-850; J. Sarama and D.H. Clements, “Lessons Learned in the Implementation of the TRIAD Scale-up Model: Teaching Early Mathematics with Trajectories and Technologies,” in T.G. Halle, A.J. Metz and I. Martinez-Beck (Eds.), Applying Implementation Science in Early Childhood Programs and Systems, (Baltimore, MD: Brookes, 2013, 173- 191); J. Sarama, D.H. Clements, C.B. Wolfe, and M.E. Spitler, “Longitudinal Evaluation of a Scale-up Model for Teaching Mathematics with Trajectories and Technologies,” Journal of Research on Educational Effectiveness, 5(2), 2012, 105-135; J. Sarama, A. Lange, D.H. Clements, and C.B. Wolfe, “The Impacts of an Early Mathematics Curriculum on Emerging Literacy and Language,” Early Childhood Research Quarterly, 27, 2012, 489-502, doi: 10.1016/j.ecresq.2011.12.002.