**Learning Trajectories (online resource)**

*Learning trajectories*, sometimes called *learning progressions*, exist in a variety of academic fields and identify empirically supported hypotheses about the paths through which knowledge and skills grow (e.g., Corcoran, Mosher, & Rogat, 2009). These progressions typically focus on a particular content area in a narrow grade band, such as the Progression on Number and Operations in Base Ten in Grades K–5 (Common Core Standards Writing Team, 2015).

These trajectories can support teachers and teams in watching for specific student development of content understandings and/or developing conceptions, which then inform instructional decisions that are learner responsive.

> *But note that, to adapt, a teacher must know how to get students to reveal where they are in terms of what they understand and what their problems might be. They have to have specific ideas of how students are likely to progress, including what prerequisite knowledge and skill they should have mastered and how they might be expected to go off track or have problems. And they would need to have, or develop, ideas about what to do to respond helpfully to the particular evidence of progress and problems they observe.* (Daro, Mosher, & Corcoran, 2011)

Research-based learning trajectories are developed through a partnership between researchers and classroom practitioners.

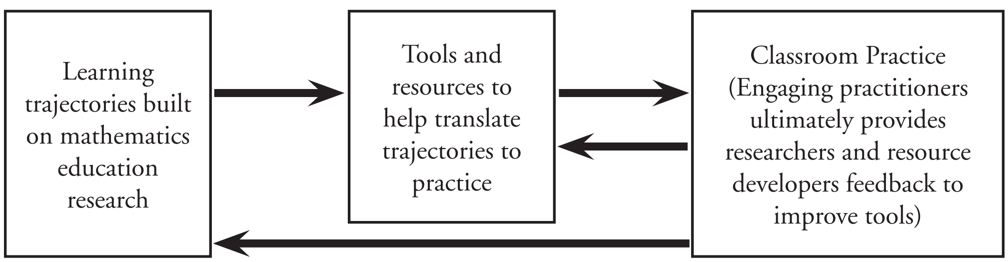


Figure 1. Learning Trajectory Development Partnership (Daro, Mosher, & Corcoran, 2011)

One example of a project that has developed learning progressions through a partnership between researchers and classroom practitioners can be found in the works of Catherine Fosnot and Maarten Dolk. Fosnot and Dolk (e.g., 2001, 2002), in the book series *Young Mathematicians at Work,* outline Landscapes of Learning.

In these landscapes, the authors identify big mathematical ideas, strategies, and models, building connected understandings. Less sophisticated strategies are located on the bottom of the page and build to more sophisticated and complex learning up the page. Thus, as children progress in their mathematical understandings, they move along a pathway of connected understanding.

An early childhood teacher uses this trajectory to sharpen the focus of the mathematical learning opportunities during group instruction and intensification. Using this map, the teacher is able to choose tasks that build from what the student already understands to new learning. Thus, the teacher is able to provide opportunities for students to connect existing ideas to solving new problems. The trajectory also informs the teacher of student partial understandings or developing conceptions that can be identified and addressed.

Research-based learning trajectories and progressions support teachers by ensuring that instruction is focused on big ideas that have a long mathematical life. Instead of trying to "fill the gaps," which is often overwhelming and impractical, trajectories provide the answer, "what's next" for this student. Learning keeps moving forward, engagement increases, and students have an opportunity to construct ideas when they are ready in meaningful and connected ways.

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In the following scenario, we explore another type of trajectory cited in *Young Children's Mathematics*. In this trajectory, we watch students to see how they solve a problem using strategies such as direct modeling, counting strategies, derived facts, or recall (Carpenter, Franke, Johnson, Chan Turrou, & Wagner, 2017).

**Scenario:**

A teacher is running an intervention group with children who are working in class on addition situations (Council of Chief State School Officers, 2010, Table 1.1: Problem Structures, p. 88). Students are able to solve joining (add to) problems with the result unknown by directly modeling the context of the problem using blocks. The teacher then asks a second type of problem, an (add to) problem with the change unknown as described below:

Given the problem: *Abby has 7 pencils. Penelope gives her some more pencils. Now Abby has 13 pencils. How many pencils does Penelope give Abby?*

The child counts out 7 blocks and puts these in one pile, then continues to count blocks making a second pile with blocks, stopping when the child gets to 13. The child then counts all the blocks (counts 13 total) and then counts the second set and says "6."

The teacher identifies the following about the student using the trajectory from Cognitively Guided Instruction:

- ☐ The student is able to use the "count three times" strategy (count 7 blocks, count more blocks to 13 blocks, then check by counting all 13 blocks again). Last, the student counts the second set of blocks and responds to the question asked.
- ☐ The student is able to model the situation accurately using physical materials, referenced as direct modeling (Carpenter et al., 2017).

Noticing these two actions by the child, the teacher then uses this trajectory to identify the mathematical ideas the child is demonstrating and thinking about those within the child's reach to decide instructional next steps. This includes attending to the problem type posed to the child and how the child responded.

To intensify instruction, the teacher uses the trajectory to assist in crafting questions to assess and advance student learning, for example, "I noticed that you counted out these blocks here (teacher points out the one group of 7 blocks), how many was that?" (Briars, 2018, Slide 38). The child responds "7" by counting all 7 blocks. "I am wondering if there is a way for us to figure this out without counting this set of blocks again?"

The teacher then walks away to allow the child time to think, connect, and attempt (Briars, 2018, Slide 38). In this case, the teacher is trying to move or nudge the child from counting all too moving to a counting strategy (such as counting on), thus moving along the strategies trajectory in Cognitively Guided Instruction from "Direct Modeling" to a "Counting Strategy."

Intensifying instruction requires teachers to be thoughtful about what the important mathematical ideas are that will enable a child to access grade-level content and ideas. Trajectories assist teachers in making choices that will focus time and further student understanding, reasoning, and success in the mathematics classroom.

Briars, D. (2018). *Productive strategies to support student's engagement in productive struggle*. Presentation at the National Council of Supervisors of Mathematics. Washington, DC. Retrieved from https://www.mathedleadership.org/member/docs/events/DC2/NCSM18_1213_Briars.pdf

Carpenter, T., Franke, M., Johnson, N., Chan Turrou, A., & Wagner, A. (2017). *Young children's mathematics: Cognitively guided instruction in early childhood education*. Portsmouth, NH: Heinemann.

Common Core Standards Writing Team. (2015, March 6). *Progressions for the common core state standards in mathematics* (draft). Grades K–5, Number and Operations in Base Ten. Tucson: Institute for Mathematics and Education, University of Arizona.

Corcoran, T. B., Mosher, F. A., & Rogat, A. (2009). *Learning progressions in science: An evidence-based approach to reform*. Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1026&context=cpre_researchreports

Council of Chief State School Officers. (2010). Common core state standards. Retrieved from http://www.corestandards.org/Math/

Daro, P., Mosher, F. A., & Corcoran, T. (2011). Learning trajectories in mathematics. Consortium for Policy Research in Education. Retrieved from https://www.csai-online.org/resource/97

Fosnot, C. T., & Dolk, M. (2001). *Young mathematicians at work: Constructing number sense, addition, and subtraction*. Portsmouth, NH: Heinemann.

Fosnot, C. T., & Dolk, M. (2002). *Young mathematicians at work: Constructing fractions, decimals, and percents*. Portsmouth, NH: Heinemann.