Learning Progressions for Algebra Readiness: A Roadmap for Assessment Design

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Abstract

This poster presents information about the development and preliminary validation of two hypothesized learning progressions for algebra readiness. Learning progressions reflect research-based hypothesized sequences of how students think and learn in a given content domain and can be used to design assessments that provide educators with information about *why* students are struggling to learn critical content in a given domain. One common method for validating these hypothesized sequences of learning are verbal protocols that provide critical insight to the cognitive processes students engage in while solving assessment problems. In this poster we present two learning progressions for algebra readiness and preliminary evidence from verbal protocols with 22 students in Grades 5-8.

Background

Learning progressions (LPs) describe the development of students' understanding within a domain and represent increasingly more sophisticated and complex understanding (Alonzo & Steedle, 2008). They are not developmentally inevitable and inflexible pathways of learning in a domain, but instead reflect a research-based hypothesized sequence of how students think and learn (Corcoran, Mosher, & Rogat, 2009). Students' development of proficiency in mathematical concepts, procedures, and strategies can be mapped along LPs (Confrey & Maloney, 2010) that can then be used to guide the design of supplemental instruction and interventions.

To design instruction to support student success within a Response to Intervention context, it is not only important to know which students are struggling but ***why*** they are struggling to learn critical concepts and skills. Student think-aloud data, or verbal protocols, are one method for obtaining such information as they provide information about the cognitive processes students are engaged in while completing a task (Ericcson & Simon, 1993), and students' understanding (or misunderstanding) of assessed content (Almond et al., 2009; Leighton, 2004).

Purpose

The purpose of this study is twofold:

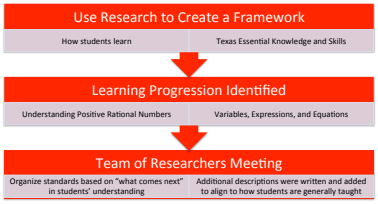
1. To describe hypothesized Learning Progressions for two facets of algebra readiness
2. To present preliminary validity evidence for the proposed Learning Progression

Method

Participants. The Learning Progressions were developed by a team of researchers, state-level math educators doctoral students, and one mathematician in Texas. Verbal protocol data collection occurred with 22 students with varying mathematics ability in Grades 5-8 attending a middle school in Dallas, TX.

Materials.

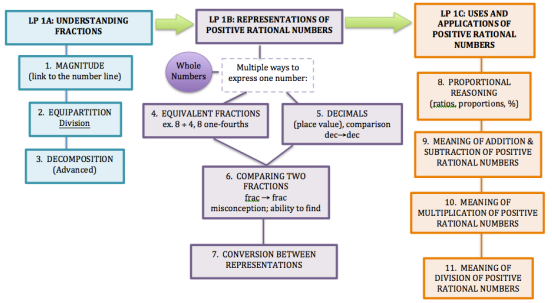
Learning Progressions development



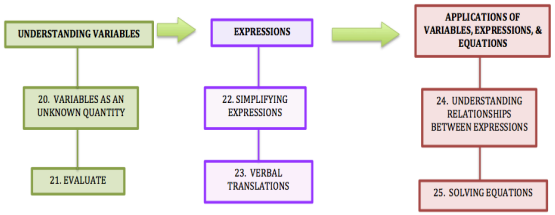
Verbal Protocol data collection. An interviewer training manual, complete with scripted model think-alouds for the interviewer to demonstrate the think-aloud task for the student was created to collect the verbal protocol data. Additionally, the manual included prompt for the concurrent think-aloud and 8 follow-up questions included for the retrospective think aloud. Students completed the think-aloud task while solving 10 multiple-choice algebra-readiness problems associated with one of the five sub-levels of the two Learning Progressions.

Learning Progressions for Algebra Readiness

LP 1: Understanding Positive Rational Numbers, their Representations, and their Uses

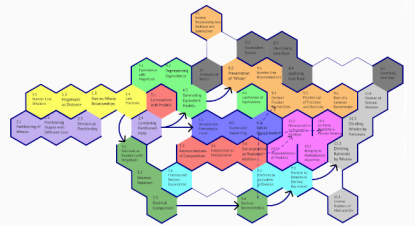


LP 2: Understanding Variable Expressions and Their Applications



And to account for the "interactions" between these ideas…

LP 1: Understanding Positive Rational Numbers, their Representations, and their Uses



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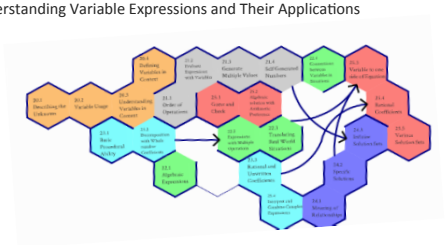

How Can This Inform Instruction?

Educators from throughout the state of Texas have written approximately 475 multiple-choice items, each designed to target a specific sub-level of one of the LPs that includes a correct answer and three distractors purposefully written to target misconceptions or errors in the LP.

What does *x* represent in this expression: 0.05*x* + 2?	
A. The number of nickels	(correct)
B. The value of a nickel	A student who chooses either of these responses does not always define the variable correctly. The misconception code for this is 20.3i(M).
C. The word nickel	
D. All of the above	

Teachers can then use information from the distractors student selected to guide instruction to target students' underlying misconceptions.

Verbal Protocol Results

Had two project staff who both contributed to the LP development independently review and code ~20% of all students' responses (e.g., concurrent and retrospective think-aloud questions). Reviewers coded for three criteria:

- Student was able to articulate his/her understanding of the problem and that response reflected content from the sub-level descriptions in the LP (sub-level agreement)
- Student was able to articulate the intent of the question as specified by the description in the LP (assumption agreement)
- Student was able to articulate *why* a correct response was correct and *why* and incorrect response was incorrect (LP verified agreement)

Inter-rater agreement in coding of students' responses for representation descriptions, misconceptions and errors from LP outline and verification of the LP outline

	# of Responses	Sub-Level Agreement	# of Responses	Assumption Agreement	# of Responses	LP Verified Agreement
LP1A	17	94%	6	100%	10	80%
LP1B	22	86%	6	100%	9	89%
LP1C	94	86%	44	80%	58	79%
LP2A	21	90%	9	89%	15	87%
LP2B	15	93%	3	100%	7	86%

Discussion

Data collected from the student think-alouds provide preliminary validity evidence of the proposed Learning Progressions. Student responses from the verbal protocols were used to inform places in the learning progression descriptions that lacked clarity or content (conceptions or misconceptions). These data were not only used to validate the learning progressions but, more importantly, to improve them for future use.

Limitations & Future Directions

To date, preliminary validity evidence for the LPs has been collected with only a small sample of students in one school district in Texas. As part of a large statewide initiative, the bank of ~475 items will be piloted with approximately 16,000 students in Grades 5-8. Information obtained from the Pilot Study will be used to construct diagnostic assessments and to help validate the proposed Learning Progressions. Professional development for teachers about the Learning Progressions and how to use them to help inform instruction are also being developed.

Note. This project is funded by Region 13, in collaboration with the Texas Education Agency.

Questions? For further information about our research, please contact Deni Basaraba (dbasaraba@smu.edu).