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Learning Progressions:

Tools for Assessment and Instruction for

All Learners

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Abstract

Conceptually, learning progressions hold promise for improving assessment and instruction by precisely outlining what students know and don't know at particular stages of knowledge and skill development. Based upon a synthesis of the literature, a rationale for the use of learning progressions maps to clarify how learning progresses in English language arts and mathematics is provided. How these maps can characterize learning for students, including those with significant disabilities and intellectual gifts, is discussed. In addition, large-scale learning progressions projects undertaken in Australia, New Zealand, and the United States are described. We conclude the paper with a discussion about specific ways in which the application of learning progression maps can enhance current assessment and instruction practices for supporting the learning of *all* students.

Within the past five years, increased attention has been paid to the concept of *learning progressions* (National Research Council, 2001; National Research Council, 2004). Although part of research agendas for more than a decade, learning progressions have only recently been recognized as an approach for improving educational practice on a large scale (e.g., Corcoran, Mosher, & Mogat, 2009; Daro, Mosher, Corcoran, Barrett, Battista, Clements, et al., 2011). This new-found interest stems from interest in mapping what students know as learning progresses to strengthen the link between educational standards, curricula, assessment, and instruction. Learning progressions already serve as the backbone of content area achievement standards developed in countries, such as Australia, Canada, China, Hong Kong, Korea, New Zealand and Singapore. In the United States, efforts are currently underway to construct learning progressions maps that are aligned with the recently released Common Core State Standards (Hess, 2010, 2011).

In general, learning progressions have been defined in the following ways:

- A "carefully sequenced set of building blocks that students must master en route to a more distance curricular aim. The building blocks consist of sub skills and bodies of enabling knowledge." (Popham, 2007, p.83).

- "A description of skills, understanding, and knowledge in the sequence in which they typically develop: a picture of what it means to 'improve' in an area of learning." (Masters & Forster, 1997, p.1).

- "Descriptions of successively more sophisticated ways of thinking about an idea that follow one another as students learn: they lay out in words and examples what it means to move toward more expert understanding." (Wilson & Bertenthal, 2005, p.3).

These definitions reflect a shared assumption about knowledge development—that learning progresses along a single continuum of increasing expertise, from emerging to mastered (for an alternative perspective, see Swarat, Light, Drane, & Park, 2009). In addition, they highlight the use of student understandings to evaluate learning improvements—to provide a qualitative description for how knowledge and skill accumulation lead to particular achievement outcomes.

Four guiding principles of learning progressions underlie the basis for their function (Hess, 2008):

1. Research informs how learning develops over time
2. Essential ideas, rules, and concepts (derived from domain or discipline experts) are mapped to characterizing learning
3. Progression represents learning movement from emergent to more advanced (although particular category labels can vary)
4. Use is informative to assessment and instruction

Recently, learning progressions maps have been developed to complement the Common Core State Standards (CCSS) for both English language arts and mathematics (Hess, 2010, 2011), suggesting a move toward understanding what students are expected to know, as well as the degree to which performance is undergirded by particular habits and dispositions, subskill proficiency, and knowledge. In 2010, the CCSS were released and adopted by 44 states and the District of Columbia (CCSI, 2012a). Unlike previous state standards, the CCSS were constructed to provide consistency across the nation (rather than within a state) so that "appropriate benchmarks for all students, regardless of where they live" could be established to "help teachers ensure their students have the skills and knowledge they need to be successful by providing clear goals for student learning" (CCSI, 2012b).

In general, the CCSS unfold performance objectives in a manner that gradually increase in complexity across grade levels. Alone, however, the CCSS fail to characterize how students are learning or what learning "looks like" as students acquire requisite knowledge and skills. They set benchmarks for when to assess student learning and for what skills or knowledge to measure, but they do not provide a blueprint for student progress toward anticipated mastery. Outlining how critical skills and knowledge develop within a particular domain is crucial for pinpointing how to adapt instruction when students get "off track" (Mosher, 2011). Rather than decompose the content to be taught, learning progressions decompose the characteristics of knowledge development, which is better suited for modifying instruction, strengthening the precision of assessments, and guaranteeing mastery toward achievement goals.

Pioneering work in learning progressions emerged from an interest in understanding how students develop scientific knowledge and reasoning skills (Corcoran et al., 2009). Learning progressions expose student thinking so that mistaken or incomplete understandings about key concepts and/or skills can be revised. For example, one early learning progression framework focused on revealing how students gradually become more sophisticated in their understanding of the atomic molecular theory of matter, emphasizing three "big ideas": all objects are composed of matter, matter can be transformed (but never destroyed or created), and that the world can be understood through measurement, modeling, and argumentation (Corcoran, et al., 2009). Across grade bands (K-2, 3-5, 6-8), levels of student understanding were mapped to show how thinking in particular stages revealed important differences in knowledge sophistication (Smith, Wiser, Anderson, & Krajcik, 2006).

In this report, we describe current uses of learning progressions in English language arts and mathematics in Australia, New Zealand, and the United States. We provide a rationale for their use, explain how they can characterize learning for all students, describe three assumptions for understanding their application, and discuss how the use of learning progression maps can improve future assessment and instructional design. We begin by clarifying what learning progressions are not.

What Learning Progressions Are Not

Because learning progressions are organized into sequential steps that can be charted, they may be confused with curriculum, or content, maps. The use of learning progressions, however, differs from the mapping of curriculum or content benchmarks for what students should learn. Curriculum maps denote grade-specific material to be covered by teachers and specific student outcomes aligned to achievement standards. Although curriculum maps are a concrete tool for arranging instruction, they reveal little about what students understand, where misunderstandings may lead to errors, and the steps necessary for mastery, which allow teachers to adapt their instruction accordingly.

For example, in an effort to support K-12 teachers in their implementation of Common Core State Standards-based instruction, English language arts curriculum maps were recently developed, and the construction of mathematics maps are currently underway (Common Core Curriculum Mapping Project, 2012). Unaffiliated with the CCSS, although intended to support them, these content maps were built with logically sequenced units that contain sample activities and lesson plans, related background information, author interviews, and suggested texts for linking with skills described in the Standards. Teachers can use these maps to design lesson plans and informal assessments. Sample lesson plans that help guide teachers in designing differentiated instruction for advanced and struggling students are also available.

Curriculum or content maps, such as these, lay out the instructional path for building knowledge and skills, but do not directly address what students know. In contrast to content maps, learning progressions maps focus attention toward what students can do at different points in knowledge and skill acquisition, providing complementary information for understanding how instruction and learning interact to build knowledge and skills.

Rationale for Using Learning Progressions

The use of learning progressions entails an emphasis on how students think; in addition to measuring skills, knowing how students reason and apply knowledge serve as the basis for knowing what they know. One benefit to learning progressions is that they emphasize "… not only on what the teachers and curriculum are trying to teach—they also try to look closely at what the students are actually attending to and learning" (Mosher, 2011, p.3). Mosher (2011, p.3) further noted that learning progressions reveal "… the ways their thinking is becoming organized in their minds…how that varies with differences in the ways teachers, textbooks, and curriculum are trying to teach them."

In addition, the National Research Council (NRC) has made the following comments regarding educational practice and research priorities that are consistent with a learning progressions approach:

- " What students should 'know' or be able to do in an area… requires an understanding of the core concepts around which the disciplinary knowledge is organized, characteristic methods of reasoning and problem solving, and language and patterns of discourse… Knowledge of students' common understandings and preconceptions of a topic and the expected progression of student teaching requires careful research on the typical trajectory of understanding." (NRC, 2004, p.15-16)

- "The model of learning can serve as a unifying element—a nucleus that brings cohesion to curriculum, instruction, and assessment. This cohesive function is a crucial one because educational assessment does not exist in isolation, but must be aligned with curriculum and instruction if it is to support learning… Assessment practices need to move beyond a focus on component skills and discrete bits of knowledge to encompass the more complex aspects of student achievement." (NRC, 2001, p.3)

These views are consistent with what proponents of developing "21st century skills" among K-12 students have noted: Educational reform requires instruction that is not just focused on limited skill development (but broader knowledge, as well) and new assessments are needed to more richly measure learning (Rotherham & Willingham, 2009). A learning progressions approach can respond to this need by presenting an explicit path in which student abilities can be mapped and charted.

For example, the Consortium for Policy in Research in Education recently identified the following benefits to using learning progressions (Corcoran et al., 2009):

- “..Provide a more understandable basis for setting standards, with tighter and clearer ties to the instruction that would enable students to meet them
- …Provide reference points for assessments that report in terms of levels of progress (and problems) and signal to teachers where their students are, when they need intervention, and what kinds of intervention or ongoing support they need
- …Inform the design of curricula that are efficiently aligned with what students need to progress
- …Provide a more stable conception of the goals and required sequences of instruction as a basis for designing both pre‐ and in‐service teacher education
- …Form the basis for a fairer set of expectations for what students and teachers should be able to accomplish, and thus a fairer basis for designing accountability system and requirements.” (pp.9‐10)

In addition, learning progression maps bring focus to the task of educating all students.

Learning Progressions for All Students

The use of learning progressions is compatible with meeting the needs of all students, not just typical learners. A learning progression “helps teachers see connections between what comes before and after a specific learning goal, both in the short and long term”, which can facilitate the making of connections between key concepts and skills (Heritage, 2008). This is crucial for differentiating instruction because in order to individualize instruction appropriately, teachers need to be able to evaluate at what level the learner is currently functioning in order to know how it should progress (i.e., what are the steps from beginning to end that characterize "knowing"). A learning progressions map can provide the background for this decision-making.

In spite of legislation that requires all students to have access to the general education curriculum, there exists little support for integrating learning needs for both typical and diverse students to better reflect current perspectives on learning (as discussed by Hess, 2012). The development of learning progressions offers the opportunity to unite definitions of academic learning for all students, by delineating a shared pathway for learning essential knowledge and skills. Furthermore, because learning progressions are supported by empirical evidence, the extent to which a developed learning progression framework doesn't characterize learning for some students can be tested. In light of emerging evidence, describing learning of essential skills on a single continuum (i.e., rather than two separate continua) makes sense.

For example, alternate assessments are currently used to measure what students with significant cognitive disabilities know. These assessments are considered to reflect grade level state standards, but at a level less complex than state achievement tests (U.S. Department of Education, 2005). However, concerns have been raised that separate (or alternate) assessments may not be living up to their promise (Browder, Spooner, Algozzine, Ahlgrim-Delzell, Flowers, & Karvonen, 2003). The problem may not be with the measures in use, but rather, with the inherent challenge of translating expectations for learning when "learning" is ill-defined. That is, at least within the United States, much more is known about what teachers should be teaching than how students build skills and knowledge as an outcome of what has been taught. At least for the development of reading (a well-studied achievement area), emerging research indicates that typical students and students with mild special needs acquire similar skills in a manner more similar than different, suggesting a common progression for learning to read (Catts, Bridges, Little, & Tomblin, 2008; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; LeSaux, Rupp, & Siegel, 2007).

Reading growth evidence among students with mild special needs. For example, in a study of 403 students, individual growth curves were compared between students with deficient reading achievement (one subgroup of students with significant reading disabilities and another subgroup with generally low reading achievement) and students with non-impaired reading achievement (Francis et al., 1996). In general, the course of reading skill development across grades one through nine was similarly curvilinear among groups, indicating less change in reading skill over time. The mean growth curves for all three reader groups revealed similar increases in reading that began to level off around age 13. Poor readers had a slightly steeper slope (or growth estimate) than the typical readers at age eight, reflecting a higher rate of change, but insufficient for "catching up" with typical readers.

The main difference between groups that was found in the Francis et al. (1996) study involved students' initial reading level (i.e., the typical group's initial level was higher than the intercept of poor readers), which contributed to persistent reading skill differences. The authors concluded that "there was no evidence that different developmental models were necessary to model change in normal children or children who met discrepancy or low-achievement definitions of learning disability" (Francis et al., 1996, p. 14). In other words, all students grew similarly in their acquisition of word reading skills (albeit at different levels, or rates, that persisted across the age range studied).

Similarly, in a study that examined reading growth trajectories among 604 students (language impaired and non-impaired readers) across grades two through ten, initial word recognition and reading comprehension skill levels were the only significant difference found (i.e., the shape of growth trajectories for the two skills across both groups were the same; Catts, et al., 2008). Consistent with the Francis et al. (1996) study, although persistent differences in performances were found between the typical and exceptional students, the shapes of the learning curves were nearly identical (although at lower levels for the students with language impairments), suggesting similar reading developmental paths.

Moreover, when growth curves of word reading and related skills among 824 English language learners (ELL) and monolingual students were compared across grades kindergarten through four, reading growth among students was found to be similarly non-linear (LeSaux, et al., 2007). Although kindergarten ELL had an initial skill level lower than the monolingual learners, by fourth grade, this difference disappeared (and on a number of tasks, ELL performance surpassed the performance of monolinguals). Moreover, for both groups of students, kindergarten letter identification was predictive of initial mean differences and growth in word reading, indicating similar key predictors of reading skill development.

Combined, the results from these studies suggest that while students' initial skill levels may vary significantly, the general trend for how reading skills develop (or progress) across different student populations are strikingly similar—they can be characterized by a shared developmental path. Much less is known about growth in mathematical skills, but it seems plausible to hypothesize similar findings based on our understanding of how skills and domain knowledge develop (Bransford, 2000; Ericsson & Lehman, 1996; Pellegrino, 2009).

Applications for students with significant special needs. Although much less is known regarding academic skill learning among student populations with more significant needs (e.g., students with significant disabilities or giftedness), theoretically, skill and knowledge learning should still follow the same path (but at perhaps different rates or levels). For example, emergent readers can recognize some letters, names, high-frequency words, and signs (e.g., “McDonalds” or “Stop”). They enjoy hearing stories and learning from informational text, and attempt to read (i.e., holding a book and “reading” aloud to themselves or others). They also behave in ways that demonstrate they understand that words covey meaning, even if they can’t read the words (e.g., asking others to tell them what the word “says”). The extent to which students with significant disabilities also exhibit these skills and knowledge over time has important implications for both instruction and alternate assessment construction (e.g., see New Hamphire’s Alternate Learning Progressions; Measured Progress, 2012).

Although learning how to read for some students with significant disabilities may not progress to advanced stages, depending upon student abilities, students with significant disabilities may still move from emergent reader to beginning reader or even transitional reader (e.g., New Hampshire’s 2012 alternate learning progression framework breaks reading into emergent, beginning, transitional, intermediate, advanced, and proficient levels; Measured Progress, 2012). For example, in a recent survey regarding the skills of students taking the alternate assessment in Kentucky, more than half of the students (67.3%) could read basic sight words or demonstrated awareness of print or Braille (Kearns, Towles-Reeves, Kleinert, &

Kleinert, 2006). Kearns et al. (2006) also found that approximately two percent of the sample could read print or Braille fluently, underscoring the diversity of academic skill development within this population. It may be that when academic "learning" is more carefully decomposed into key landmarks along a particular path, descriptions of progress can become more fine-grained, and therefore, more inclusive of wider ranging abilities. When progress is measured in terms of vague leaps, the precision for capturing growth is severely limited, rendering more incremental strides indiscernible.

At the opposite end of the ability scale, the same trajectory for learning how to read could be useful for guiding instruction and assessment efforts for students with extreme cognitive gifts. For example, decoding rapidly, reading connected text fluently, and possessing a vast vocabulary (characteristics of gifted readers; Levande, 1993) are insufficient for gauging the extent to which extremely bright children are also proficient readers. Progress made by students who read above grade level often goes unnoticed because the performance of these students exceeds grade-level expectations (and is therefore not monitored with precision). Part of the problem results from psychometric scaling limitations plaguing most progress monitoring measures currently available on the market. However, part of the problem is due to unclear characterizations for how essential knowledge and skills fully develop (i.e., not restricted to within a particular grade) and therefore, when they are mastered.

For example, in addition to possessing strong reading capabilities, proficient readers need to also possess positive habits and attitudes about reading and demonstrate the ability to read different texts for different purposes (as outlined by the New Hampshire learning progression maps for English language arts; Measured Progress, 2012). Expectations for these "habits of mind" go well beyond developing decoding or comprehension ability; they expand what it means to fully develop as a proficient reader. Although advanced students may exhibit strong decoding and comprehension, this does not guarantee that positive habits and dispositions about reading are also developed. Thus, the use of a learning progressions framework would better clarify which elements of reading instruction could be "compacted" to better meet the needs of high ability readers (Dooley, 1993), as well as specify particular areas of instructional need that could be expanded to "round out" relatively weaker areas of skill or knowledge (e.g., the development of positive reader habits). Moreover, the extent to which reading proficiency has been reached (regardless of grade-level achievement expectations) can also be clearly established and used as a basis for making instructional decisions.

Cognitive Psychology Foundations: A Basis for Understanding how Learning Progresses

The concept of learning progressions has roots in cognitive psychology because of the emphasis on student thinking and learning. In this section, we describe some critical assumptions that stem from cognitive psychology principles that implicitly underlie uses of learning progressions (Bruning, Schraw, & Ronning, 1999):

- **Learning is a constructive process** (i.e., "learning is a product of the interaction among what learners already know, the information they encounter, and what they do as they learn", p.6)

- **How knowledge is organized within the learner is important** (e.g., learning misconceptions and errors are useful information for understanding what students know and don't know, and beginners view and manage learning differently than advanced learners within a particular domain)

- **Social interaction is an important element of cognitive development that fosters learning growth** (i.e., teachers can provide meaningful and appropriate practice and feedback opportunities, and more knowledgeable peers can help shape "ways of knowing" or particular "habits of learning")

Learning is a constructive process. Learning progression maps can help capture increases in language and concept sophistication that reflect how learning is accumulated over time—it entails a process by which encapsulated knowledge become increasingly more refined and efficient, building on already acquired knowledge and modifying it to create knowledge webs that efficiently interlace. Skill development progresses in much the same way; with practice, performance becomes more competent and builds upon prior skill level (Ericsson & Lehman, 1996). Learning progression maps employ a focus on the development or trajectory of learning for a particular skill or body of knowledge. Like a staircase, a series of steps can be plainly laid out to demonstrate a learning continuum encompassing what students are likely to do (or know) at the beginning of development on through to mastery, based on learning theory and observation. This does not require grade-specific benchmarks, although they may be developed to coincide with such targets (e.g., see Hess, 2010, 2011).

Knowledge organization within the learner is important. Learning progression maps are based on current perspectives of human learning, and more specifically, how knowledge becomes more sophisticated as the learner moves from beginner to proficient. For example, within a content domain, high and low student performance can be characterized as differences in how knowledge is organized and used (and better utilization of knowledge fosters enhanced skill development). More sophisticated strategy use, efficient knowledge access, and extended practice with sufficient opportunities for feedback underlie demonstrations of more proficient performance (Bransford, 2000; Ericsson & Lehman, 1996; Pellegrino, 2009).

One key characteristic of learning progression maps is that they reveal how knowledge is structured at pivotal points in the learning process, which benefits prioritization of essential knowledge or skills for both instruction and assessment (Heritage, 2008). This is important for clearly identifying whether students are developing critical thinking skills within particular domain areas, or where misconceptions might be responsible for performance errors. The ability to anticipate the knowledge, skills, and thinking of students at particular points in their learning can make for a valuable assessment tool. For example, advances in psychometric modeling have exploited the use of student misunderstandings to develop specific test item distractors. Items can be written so that the selection of particular distractors can reveal specific misunderstandings that lead to erroneous performance, increasing their sensitivity for diagnosing learning problems (Mislevy, 1993).

Social interaction is an important element of cognitive development that fosters learning growth. Vygotsky theorized that learning could be advanced within a “zone of proximal development” (Vygotsky, 1978). In essence, his theory suggested that learning is the result of moving students through a gap between what is known and unknown. To do this, students need a more knowledgeable other who can provide strategic practice intended to further knowledge or skills based on the student's present level of performance. No doubt teachers fill this role, but the extent to which they can manage scaffolding many students with diverse needs is uncertain. In fact, in a recent national survey, teachers named "meeting the needs of all students" as the greatest challenge their profession faces both currently and in the future (MetLife, 2008). To successfully move students through this "gap", teachers need the following types of knowledge: domain or discipline (i.e., content), pedagogical (i.e., instructional methods), student present level of functioning (i.e., acquired knowledge and skills), and assessment (Heritage, 2007). How learning progresses as a result of instruction lies at the foundation of these sources of knowledge that teachers need to know.

Because learning progression maps are defined within a domain or discipline, teachers are provided with a clear trajectory for learning within a particular content area. This information creates a clear path for pinpointing where on the trajectory his or her students fall initially as well as next steps in learning, which can benefit instructional plans and boost the explanations of assessment results. Rather than guessing about a student's present level of functioning, formative assessments that are congruent with a learning progressions map can be developed easily and with continuity toward particular learning goals based on expectations set by the CCSS. Armed with this knowledge, teachers who have learning progressions maps to work with are undeniably empowered to be more effective than those who do not (Hess, 2012).

Learning Progressions in Practice

In this section, we selectively review pioneering and current advances in the development and use of learning progressions frameworks at a national level in Australia, New

Zealand, and the United States. Although learning progress maps are used in other countries, we found limited information regarding their application, and therefore, focused on these countries to give the reader a sense for how learning progression maps are furthering improvements in education at a national level. We discuss models pertaining to English language arts, followed by mathematics.

English language arts models. ***Australia*.** As part of a seven-year longitudinal study to examine literacy and numeracy development funded by the Australian government, one of the earliest learning progressions maps was constructed. As a result of this study, which began in 1998, Marion Meiers (the project director) was commissioned to write the Victorian State Essential Learning Standards in 2005, including progression points (ACER, 2012). By following a single cohort of more than 1,000 children from a random sampling of 100 schools, Meiers and colleagues studied patterns of growth pertaining to literacy in the following areas: Concepts about print, phonemic awareness, reading fluency, making meaning from text, and writing (Meiers, 2004). Using Rasch modeling (i.e., item-person mapping) of assessment results over time, typical learning across these five areas were constructed to provide educators a map of typical progress for measuring, describing and monitoring literacy growth over time. For example, project findings revealed incremental knowledge building among beginning readers that ranged from being able to identify writing presented in a picture to sign reading, to letter and word identification (Louden, Rohl, & Hopkins, 2008). This information was used to inform professional development (e.g., see the First Steps program at Edith Cowan University) as well as standards development described above. The direct impact of these learning progression maps for educational practice is currently unknown as the Australian national curriculum is under development (ACARA, 2012).

***New Zealand*.** Alongside the development of the National standards, the New Zealand Literacy Learning Progressions was developed in 2007 as a tool to help teachers become aware of the literacy-related knowledge, skills, and attitudes that students need to know in order to meet the reading and writing demands of the New Zealand Curriculum from year 1 through 10 (NZME, 2010a). This tool was designed specifically as a reference, and not as an assessment tool or a teaching program. Three main aspects of knowledge, skills, and attitudes were emphasized: understanding written language code (including phonological awareness, the alphabetic principle, knowledge of how words work and automatic recognition or spelling of familiar words), knowing the meaning of texts (including knowledge relating to culture, language, and identity, vocabulary, the structure of language, literacy, and strategies to get or convey meaning), and the development of critical thinking skills (including the ability to analyze and respond to texts).

The New Zealand learning progression map is broken down into levels of proficiency by color codes (NZME, 2010a). For example, students falling in the "magenta" level can do the following: know that print can express ideas and that reading proceeds from left to right, expect that text "makes sense", and are in the process of building a reading vocabulary of high-frequency words. In contrast, students in the "blue" level (i.e., highest proficiency group) can do the following: monitor their reading across longer and varied texts, use multiple sources of information to think critically about what they've read, recognize words automatically, read silently, and use comprehension strategies to generate meaning from text (e.g., ask questions and evaluate text effectiveness). Similar to the Australian progression maps, the progress of learning is not decomposed by grade level, but rather by proficiency level.

United States. In 2010, nationally recognized reading and writing content experts and researchers were asked to identify specific content strands and associated “enduring understandings”, as part of the development of a learning progressions framework (Hess, 2010). Using reviewed research, this committee identified corresponding learning targets within three age spans: K–4, 5–8, and 9–12. Four reading strands were initially developed, and three writing strands were later added. Habit and dispositions were outlined to encompass both reading and writing. In addition, essential skills and concepts needed to achieve age span expectations were pinpointed, as well as when they emerged within more narrow age bands (K–2, 3–4, 5–6, 7–8, and high school). These descriptions were considered “progress indicators” as a way to illustrate a general learning continuum in which earlier skills within the sequence presumably establish the foundation for later skill and knowledge development. As a final step, alignment of the progress indicators with the Common Core State Standards for English language arts was examined. In light of research findings, progress indicators that could not be directly linked with a Standard remained within the framework to guide instruction and assessment efforts.

Seven learning progression strands were identified: Reading and writing habits and dispositions; reading/making meaning at the word level; reading literature/making meaning at the text level; reading informational texts/making meaning at the text level; writing literary texts/communicating ideas and experiences; writing to inform/communicating through informative texts; and writing persuasively/communicating opinions, critiques, and arguments.

These strands were not meant to be linearly related, but rather integrated as part of a comprehensive learning map that gradually increased in complexity across development. For example, within the *habits and dispositions* strand, the overall learning target remained the same across age spans, but unfolded more complexly over time. In K-4, students are expected to use self-selected print/non-print texts and self-monitoring strategies and tools to comprehend and enjoy reading, as well as explore and improve written and oral communication. The same learning target for middle school delineated more sophisticated behaviors in that students comprehend, sustain, and enjoy reading as well as improve and expand written and oral communication. By high school, this learning target characterized the development of reading and writing habits and dispositions as expanding personal and academic knowledge (rather than merely comprehending and enjoying text), and reflecting on perspectives of self, others, and the world through oral and written communication.

Within each learning target, "mini" learning progressions are also evident and can be expanded as needed to support students with special needs within particular grades. For example, within the r*eading/making meaning at the word level* strand, one of the learning targets entails students' ability to apply knowledge of phonics, word structure, word relationships, and context to read and understand unfamiliar words in connected text. By outlining age span expectations (rather than just grade level expectations) the learning progressions framework sets explicit mastery goals for when students should possess essential skills to support the next steps in their knowledge building. The delineation of reading skill development within the learning progressions framework makes clear where students are on the path to mastery, as well as which specific concepts and skills that may need additional support, providing powerful information to teachers for differentiating instruction and assessment design.

At this point in time, student understandings are anticipated based upon literature reviews, rather than empirical findings. In addition, the framework resembles a charting of grade-level performance objectives, rather than a presentation for how English language arts knowledge and skills develop as a consequence of increasing mastery (i.e., different proficiency levels are not delineated). However, because the development of the U.S. learning progressions map is so recent, it is unknown at this point how applications of its use will evolve.

Mathematics models. ***Australia*****.** As previously mentioned, as part of the Australian Council for Research in Education (ACER) longitudinal study of literacy and numeracy, a learning progression map for how knowledge pertaining to numbers, space, as well as chance and data was developed (Meiers, 2004). Using Rasch modeling (i.e., item-person mapping) methods, the researchers were able to compare the skills and knowledge of students in these areas at different levels of achievement (e.g., percentiles).

In 2007, the Victorian state within Australia released a mathematics developmental continuum learning progress map to support to support achievement toward the Essential Learning Standards (VDEECD, 2012). Using empirical evidence, such as the ACER longitudinal study (Meiers, 2004), five areas of mathematics knowledge were mapped: number; space; measurement, chance and data; structure; and working mathematically. Progress indicators ranging from .5 to level 6 were used to capture different points in mathematics development. For example, at level .5 within the number dimension, students understand one-to-one correspondence between numbers, whereas at level 3, students demonstrate fluent recall of multiplication facts, and by level 6, students understand the Euclidean algorithm (VDEECD, 2007).

More than just a charting of student abilities, this learning progression map also identifies student misunderstandings that signal the need for greater attention. For example, four misconceptions suggest the need for improving students' understanding of the significance of zero (VDEECD, 2007): 1) students think that 3.720 is greater than 3.72; 2) students overgeneralize when multiplying by 10 (e.g., 1.53 x 10 = 1.530), 3) students error in thinking that 4.086 = 4.86, and 4) students erroneously think 32= 032= 0032. Combined, this map delineates where students fall in their development of mathematics knowledge (including what they've mastered and what they have yet to learn), as well as common errors in thinking that hinder mastery.

***New Zealand*.** New Zealand has also developed a learning progression map related to their national curriculum. This matrix of progress indicators addresses learning in the following mathematics strands (NZME, 2010b): numbers related to fractions, numbers strategies (e.g., counting, adding, multiplying), measurement, geometry and tessellations, algebra and exploring patterns, statistics related to data display, and statistics related to probability. Student progress levels range from 1-5; these levels represent mastery and not academic grade. For example, students in level 1 in their understanding of fractions can identify half or a quarter of a region, whereas students in level 4 can convert fractions, decimals, and percentages. As part of this mapping effort, explanations and example displays for what students can do ("what the work shows”), recommendations for next steps (“where to next?”) and how to measure progress, as well as related links to the curriculum (NZME, 2010b).

United States. In 2010, two committees comprised of educators from 17 states, 8 colleges and universities, and 7 state or national organizations helped to construct a learning progressions framework in mathematics (Hess, 2010). The first committee (made up of content experts and researchers within both general and special education) was charged with reviewing the research literature pertaining to mathematics learning and developing a conceptual learning progressions framework. The framework identified “enduring understandings” and essential learning targets consistent with the Common Core State Standards for three different age spans: elementary, middle, and high school. The second committee (made up of master teachers and education professional development experts, both of which reflected classroom experience across the three age spans) decomposed the progressions into “mini-progressions”, adding progress indicators within grade spans, which were used to design instructional modules to illustrate how these progressions could be used in the classroom. In addition, suggestions were made for how to support students with significant cognitive disabilities within each lesson plan to allow for content accessibility for all students.

Six major mathematics strands were identified: symbolic expression; the nature of numbers & operations; measurement; patterns, relations, & functions; geometry; data analysis, probability, & statistics. These strands were not meant to be linearly related, but rather integrated as part of a comprehensive learning map that gradually increases in complexity across development. Once the essential skills and concepts needed to reach grade span expectations were established, research syntheses were used to order the skills and concepts across more specific grade spans: K--2, 3--4, 5--6, 7--8, and high school. As a final step, alignment with the Common Core Standards was examined, both from forward (i.e., beginning at kindergarten) and backward (i.e., beginning in high school) perspectives. Because the focus was on describing learning (and not describing the path to standard achievement), some essential skills and knowledge characterized were not specific to the Standards (although alignment reported between the learning progression maps and the Standards ranged from 83--100%). Furthermore, the correspondence between essential knowledge and standards was not exact—some standards were linked to more than one progress indicator based on the committee's understanding for how skills and knowledge emerge within the age spans used.

For example, according to this learning progressions framework, within the strand *symbolic expression*, learning entails using and manipulating mathematical symbols and expressions for representing problems when problem solving and expressing concepts, relationships, and reasoning. In K--4, students gain an understanding for number sense and representing numerical relationships (e.g., 3< 5), solve for unknown quantities (e.g., 3 + ___= 5), and write equations that demonstrate inverse operations (e.g., how addition and multiplication are related). In middle school, students represent mathematical relations symbolically and solve algebraic expressions. In high school, this body of knowledge is used for representing and interpreting multi--step problems, demonstrating the relation between equations and matrix representations or between functions and modeling. Thus, gaining symbolic expression knowledge progresses from developing "number sense" as students begin school, to representing complex numbers and their abstract relations by the time they complete school.

More specifically, within *data analysis, probability, and statistics*, one of two progress indicators identified within the elementary age span states that students will demonstrate that they can pose questions of interest that can be answered by counting/collecting. In kindergarten, Counting and Cardinality Standards 5 ("Count to answer 'how many?' questions") and 6 ("Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group") are linked with student ability to pose questions that can be answered by counting. In first grade, students should be able to order and compare objects by length, demonstrating a more abstract use of counting that is aligned with the measurement and data CSS 1. By second grade, students should be able to measure object lengths more precisely as well as solve addition and subtraction word problems using the same units (reflected in Measurement and Data Standards 2 and 5). For students with special needs, each of these learning targets could be further decomposed into more developmentally appropriate sequences.

Thus, the mathematics learning progressions framework developed in the United States, through the work of Karin Hess, carefully aligned "progress indicators" for what students should be able to do within particular content domain strands that correspond with the Common Core State Standards. See Hess (2010, 2011) for concrete examples for how learning progression learning targets, progress indicators, and the Common Core State Standards are interwoven within mathematics and English language arts. However, unlike other learning progressions frameworks reviewed, at least currently, clear stage or level demarcations beyond grade level are not apparent for describing student progress (e.g., as described in Heritage, 2008, or

Measured Progress, 2012). In addition, similar to the English language arts framework, student abilities are based upon literature reviews, rather than empirical research undertaken.

Future Directions for Assessment & Instruction

> "…A progressions approach ought to provide a basis for developing more precise evidence of where students are on their path to meeting standards and helping teachers understand the implications of what evidence in ways that would help them adapt their instruction to their students' particular needs" (Mosher, 2011, p.7).

In this report, we have described current work in the area of learning progressions, as well as the rationale for their use. In this final section, we discuss the potential for innovative outgrowths of a learning progressions approach. In particular, we focus on two critical directions: improvements in assessment design and novel approaches to instructional practice.

Improvements in assessment. New methods in the area of item response theory (IRT) have boosted innovative practices in test development. Once seen as separate types of tests, cognitive and achievement measures have recently been melded to create a new type of test designed to reveal students' thinking based on particular patterns of test item responding. For example, IRT modeling could be used to show how particular groups of students responded to specific test elements (e.g., presentation format or specific cognitive process engagement, as discussed by Embretson & Reise, 2000), particularly among students at different levels of knowledge or skill. This could be used to provide crucial information regarding the underlying factors hindering test performance (Embretson, 2002), as well as how it changes over time (Embretson & Reise, 2000).

A second extension of this idea would be to categorize test items in relation to particular ways of thinking, or schemata (Rumelhardt, 1981). For example, math problems could be developed to measure knowledge at particular levels assigned by a learning progression map: emergent, beginning, advanced, proficient. Test results could clarify the extent to which students at particular points in a math learning progression map possess knowledge about represented problems and ways of thinking commensurate with qualitative descriptions (Singley & Bennett, 2002).

More generally, the development of learning progression maps would benefit the design of computer-adaptive assessments, by clarifying directions for how the test should respond to student performance (i.e., administer easier or hard items). For example, dynamic learning maps are currently being developed as part of an alternate assessment for students with disabilities in which test items can be administered more sensitively based upon student responding (Dynamic Learning Maps Consortia, 2012). Similarly, learning progression maps could be used to identify potential student misconceptions, which could be incorporated into distractors to reveal more detailed information regarding errors in performance (as previously discussed; Mislevy, 1993). This type of information would be especially useful for guiding instructional decision-making.

***BEAR Assessment System*.** One example of an assessment system that links cognitive and developmental goals of a curriculum is the BEAR Assessment System (BAS; Wilson & Sloan, 2000). BAS uses four guiding principles when developing assessments with sound measurement: (1) building assessment from a developmental standpoint, (2) aligning the assessment with the instruction, (3) ensuring teachers can manage and use assessment data; and (4) the generating of valid and reliable classroom assessment. Grounded by the four principles, BAS advocates the development of quality instruments through four building blocks: (1) Construct Maps, (2) Items Design, (3) the Outcome Space, and (4) the Measurement Model. These building blocks correspond to the Assessment Triangle in the *Knowing What Students Know* report (NRC, 2001) developed by the National Research Council.

The first building block, Construct Maps, represents the theory of cognition underlying the processes of student learning, with the ultimate goal of determining whether students move from being a novice to an expert in a domain. A construct map describes different levels of knowledge in qualitative terms to reflect students' level of understanding, akin to a learning progression map (Wilson, 2009). Items Design is guided by the principle that there should be a match between instruction and assessment. The Outcome Space details the different levels of responses for a particular prompt associated with the construct map. Such descriptions can be used by teachers to draw inferences about student knowledge and understanding to improve learning outcomes. The Measurement Model is the last building block for developing a valid and reliable assessment that will allow teachers to infer about their students' level of understanding based on their assessment scores. BAS offers programs like GradeMap (Kennedy, Wilson & Draney, 2005) that produces maps to graphically represent students' level of understanding of a particular construct.

Therefore, the BEAR assessment reflects a new direction for assessment, in which the measurement of what a student knows is more closely linked to instructional implications. It also facilitates interpretations of student understanding and proficiency based upon a clear construct (i.e., learning progression) map. This type of assessment can support learning by precisely and directly informing the instruction a student receives.

Improvements in instruction. In 2007, Hawai'i Progress Maps were developed to "improve teaching and learning for all students in science, mathematics, and language arts" (Hess, 2012, p.2). The learning progression maps were constructed to decompose how students in Hawai'i would reach the state-defined benchmarks. In particular, the thrust behind this effort was to carefully examine the needs of struggling learners and how the Maps could be used to enrich formative assessment, strategy use, and targeted scaffolding efforts. Both general and special educators participated in the implementation of the Progress Maps.

In general, at least 80% of teacher participants reported an increased use in formative assessments, instructional strategies, and modifications to instruction, in response to student needs (Hess, 2012, p.12-13). In addition, progress maps "provided a clearer understand [sic] of what 'within grade level progress' could look like", which advanced teachers' ability to monitor progress (Hess, 2012, p.13), and progress map use improved teachers' understanding of assessment and how to translate implications of assessment results into classroom practice. The maps also encouraged collaboration because they afforded teachers common ground for discussing hypotheses about student progress. Most critically, "teachers' perceptions of the slowest progression students shifted for some (not all) teachers who began to see…what the students could do, not what they could not do." (Hess, 2012, p.17). However, as noted by Hess (2012), effective use of the progression required: collaboration time, clear instruction and assessment models along with a common language for communicating, content and pedagogical knowledge, special educators as part of planning and instruction teams, and school-level leadership.

Although not a panacea, the development of learning progression maps appear to be a step in the right direction. When constructed with the learner's thinking in mind, they provide a concrete tool for guiding instruction to foster proficiency success. Learning progression maps also pinpoint ways to enhance assessment to more clearly describe what students know and pinpoint critical misconceptions that hinder learning. Existing school practices tend to categorize students, either by ability or grade level. The key potential behind the development of comprehensive learning progression maps is that they delineate a path of learning for all students, with a full appreciation of individual differences (i.e., it is generally accepted that students will learn at different rates and fall at different places on the same learning trajectory). This view of capturing learning facilitates efforts to "fit" assessment to the abilities of learners and differentiate instruction on the road to mastery, rather than focus on how far students' current levels of functioning are from expected grade-specific achievement outcomes. This requires a shift in thinking, but such a change may enable more adaptive teaching, learning, and assessment that better serves educational reform for all students.

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