



Considerations for Selecting a K-12 Supplemental Mathematics Diagnostic Intervention Program

Carnegie Learning® Math Solutions

Responses submitted by: Carnegie Learning, Inc.

KCM Disclaimer

This document presents useful criteria with vendor responses regarding a particular program and may be used by schools as an informal decision-making tool. It is important to note that **these vendor responses do not necessarily reflect the educational positions of the Kentucky Center for Mathematics.** Readers are encouraged to critically evaluate all vendor responses.

KCM Definitions

A supplemental mathematics diagnostic intervention program is a research/evidence-based program that is used in conjunction with a core curriculum. The essential components of such a program include diagnostic assessments and data-driven differentiated instruction.

A dynamic diagnostic assessment is an asset-based measure designed to precisely ascertain a student's level of readiness for learning mathematics. These assessments typically focus on interactions among student, teacher, and task with the intention of dynamically reforming the testing landscape to accommodate the individual. See the explication at <http://kymath.org/intervention/doc/2008/Dynamic%20Assessment.pdf>.

Purpose

This document presents useful criteria for informal evaluation of a diagnostic intervention program and may be used as a general selection guide. This document is not designed to serve as a selection guide for specific intervention strategies. *We strongly recommend consulting with a mathematics education specialist when making any decisions regarding mathematics curricula.*

Connection to NCTM Guidelines

This document was prepared independently of the NCTM guidelines regarding the creation or selection of an intervention program. Alignment to NCTM intervention guidelines are noted where appropriate. NCTM intervention program guidelines and additional information concerning mathematics intervention may be found by searching for keyword *intervention* at www.nctm.org or access the NCTM guidelines directly at the following web address:
[http://www.nctm.org/uploadedFiles/Lessons_and_Resources/Intervention_Resources/Intervention%20Programs%20\(NCTM,%20Nov%202007\).pdf](http://www.nctm.org/uploadedFiles/Lessons_and_Resources/Intervention_Resources/Intervention%20Programs%20(NCTM,%20Nov%202007).pdf)

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Program Foundations (*NCTM Topic 1: Diagnostic Assessment; Topic 2: Instructional Activities; Topic 5: Research Supporting Intervention*)

- 1. To what extent is the program based on accurate mathematics and solid theories of teaching and learning which develop conceptual understanding among students?**
NCTM 2.4

VENDOR RESPONSE:

The Carnegie Learning® Cognitive Tutor® software is based on cognitive science research begun in the 1980's at Carnegie Mellon University (CMU) by Dr. John Anderson, Professor of Psychology and Computer Science. Anderson and his team developed software that combined models of how people learn with powerful computing tools. In 1990, Anderson joined forces with Bill Hadley, later the 1995 Presidential Math Teacher of the Year and founder of Carnegie Learning, to expand the software and create the first Cognitive Tutor Algebra curriculum. Initially piloted at Langley High School in Pittsburgh in 1992, the Cognitive Tutor expanded to 75 U.S. schools by 1998. That same year, Carnegie Learning was incorporated as an independent company to commercialize the Cognitive Tutor technology. Carnegie Learning maintains a close partnership with CMU encompassing ongoing technology transfer and exchange of research ideas.

Carnegie Learning® Math Solutions are based on how students think, learn, and apply new knowledge. The curricula use students' intuitive problem solving abilities as a powerful bridge to formal and sophisticated mathematical comprehension. Instead of students practicing isolated skills and assuming that these procedures will lead to problem solving, Carnegie Learning solutions start with real-world scenarios and ask students to do a lot with "the math."

Classroom activities address both mathematical content and Process Standards as identified by NCTM's *Principles and Standards for School Mathematics*. Students engage in problem solving, communication and reasoning while making connections using multiple representations. Our unique cognitive modeling technology, the Cognitive Tutor, identifies strengths and weaknesses in student's mastery of mathematical concepts and individualizes instruction to focus on specific skills. This continual assessment of student knowledge is available immediately to teachers and students, resulting in ongoing formative assessment completely integrated with instruction.

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Carnegie Learning believes that the learning principles presented in *How People Learn* (Bransford, Brown, & Cocking, 1999) are critical. Student materials, teacher resources, and professional development have been developed using these principles:

- Learning with understanding is facilitated when new and existing knowledge is structured around the major concepts and principles of a discipline.
- Learners use what they already know to construct new understandings.
- Learning is facilitated by use of meta-cognitive or reflective strategies that assist learners in identifying, monitoring, and regulating their cognitive processes.
- Learners have different strategies, approaches, patterns of developed abilities, and learning styles because of interactions between their opportunities to learn and their prior experiences.
- Learning is situated in activity and is shaped by the context and culture in which it occurs.
- Learners' motivation to learn and their sense of self affect what they learn, how much they learn, and how much effort they will put into learning.
- Learning is enhanced through socially supported interactions.

2. To which levels of the intervention program does the developer's research apply?

VENDOR RESPONSE:

Tier 1: Universal

You can implement Carnegie Learning Curricula as your universal curriculum for all students. Our core curriculum model helps students obtain a deep conceptual understanding of the math. Students spend more time learning working on engaging math programs in groups and independently.

Implementation Model: A daily instruction model where students spend more time being active learners during class periods as they work in small groups or independently to solve engaging math problems. Each student is given a Carnegie Learning Consumable Text that they can write in, take notes in, highlight key data in a problem, and show his/her work to solve a problem. Teachers encourage and facilitate classroom

discourse about mathematics. Students are expected to regularly prepare, present, and discuss solutions to math problems.

Tier 2: Strategic Intervention

We can target students' skill deficits in our Cognitive Tutor Software. It is the most powerful mathematics software for differentiating instruction. Each student receives a truly individualized learning experience because the software adapts to their learning needs. Students are also provided support while they learn in the forms of just-in-time feedback and hints. They're designed to be very specific to help a student persist to solve the math problems.

Implementation Model: Provide supplemental instruction via Cognitive Tutor software. Assign the curriculum to students and based upon their knowledge and performance the software will present problems to address student weaknesses. Alternatively, teachers can selectively assign units as needed for practice, re-teaching or reinforcement as needed in addition to instruction received from the core curriculum.

Tier 3: Intensive Intervention

At-risk students need more time and practice to master math skills. We provide teachers with the ability to create a custom curriculum sequence to target students' weakest skills. We also offer interactive review sessions for students who need to refresh their understanding of material they've studied previously. We have additional print materials, like a Homework Helper to extend instructional time into the home. Each homework helper volume contains instructions so parents can assist their child if needed.

Implementation Model: Additional daily instruction leveraging both Carnegie Learning Texts and Cognitive Tutor Software.

Example: Students needing an intensive intervention are enrolled in a math support class and Algebra I class concurrently. The Math Support class can address math fundamentals and deepen math understanding required to progress in Algebra I.

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The primary theoretical basis for the Cognitive Tutor approach comes from John Anderson's ACT-R model of learning and performance (see <http://act-r.psy.cmu.edu/> and Anderson, 1993; Anderson and Lebiere, 1998; Anderson, 2007).

The ACT-R theory states that performance knowledge (i.e., how to do math) can only be learned by doing, not by just listening or watching. Using this theory, a cognitive model of problem solving was created by writing "if/then" rules that reflected and anticipated students' various strategies for solving math problems and the common misperceptions they had that led to missteps and wrong answers. Using these if/then rules, the resultant Cognitive Tutor can follow students through their problem-solving activities using model tracing, a technique that identifies each step a student takes to solve a problem. Errors, such as the ones the student made in the above example, can be quickly addressed.

The ACT-R theory proposes that complex problem-solving tasks are accomplished through the operation of many relatively-simple mental skills. The most effective and efficient instruction focuses on helping students identify the component skills for each task and on ensuring that students receive adequate practice on each of the component skills. This model of learning is the basis for the Cognitive Tutor's formative assessment, differentiated instruction and mastery-based approach.

ACT-R's success in modeling human cognition has been supported by hundreds of experiments (see <http://act-r.psy.cmu.edu/publications/index.php>). The specific application of ACT-R to mathematics education within the Cognitive Tutor has been supported by over 100 experiments. Field experimentation focusing on testing and improving the effectiveness of Cognitive Tutor® Math Software continues in conjunction with the Pittsburgh Science of Learning Center (see www.learnlab.org and <http://www.learnlab.org/research/papers.php>).

3. Are there randomized trial experiments that prove positive effects on student achievement? NCTM 5.1

VENDOR RESPONSE:

Carnegie Learning has a fundamental commitment to the ongoing study of the effectiveness of our curricula with the goal to always improve our solutions. We believe in collecting data to analyze which specific components of our solution are working and which have room for improvement. Our focus is not only on *what works*, but *why it*

works. Understanding the reasons for effective instruction allows us to more easily extend our approach to new areas of teaching and learning.

The U.S. Department of Education's What Works Clearinghouse identified a study of our Algebra I solution as one of the very few studies that shows significant, positive effects on learning and student attitudes in a strong experimental design. In this study, conducted in Moore, Oklahoma (Ritter, et. al., 2007), classes were randomly assigned to condition, within-teacher (that is, each teacher taught some classes using the Cognitive Tutor curriculum and others using a control textbook). Random assignment within school year and within teacher controls for cohort effects and teacher effects. Data were analyzed using hierarchical linear modeling, to account for the fact that assignment was by class, rather than by student. The study also included an extensive analysis of attrition, ensuring that differential attrition could not account for the positive effects of Cognitive Tutor on student performance and attitudes. This study was recognized by the What Works Clearinghouse as meeting their highest standards for evidence, and was accepted for publication in a peer-reviewed conference.

Carnegie Learning® Math Solutions have been reviewed extensively by third party researchers, and, overall, results of dozens of well-designed studies indicate that, when using Carnegie Learning programs:

- Students performed 30% better on questions from the TIMSS assessment
- Students demonstrated an 85% better performance on assessments of complex mathematical problem solving and thinking
- Students completing Cognitive Tutor® Algebra I had a 70% greater likelihood of completing subsequent (non-Cognitive Tutor) Geometry and Algebra II courses, as compared to students completing a traditional Algebra I course
- Students in Cognitive Tutor® Algebra I achieved 15-25% better scores on the SAT and Iowa Algebra Aptitude Test, as compared to students using a traditional curriculum
- Results have generally been equivalent for both minority and non-minority students

We continue to participate in third-party research intended to improve teaching and learning models and practices including:

- Large-scale randomized field evaluation of Cognitive Tutor® Geometry

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- Randomized field evaluation of Cognitive Tutor® Algebra I in four school districts
- Over 20 controlled experiments on variations of the Cognitive Tutors in conjunction with the Pittsburgh Science of Learning Center
- Analysis of student learning in Bridge to Algebra, using a data set that represents the most detailed record of student mathematical behavior ever collected
- Working with Southern University, a historically Black college in Baton Rouge, Louisiana, to build tools allowing teachers to build their own Cognitive Tutor activities
- Working with Carnegie Mellon University and Worcester Polytechnic Institute to develop statistical methods for using data from Cognitive Tutors to predict and improve scores on state tests

An electronic library of completed research reports is available at www.carnegielearning.com, including the following:

[Kent School District](#) (Adobe PDF)

WA, 2003, Algebra I, study of 779 students, urban public schools

[Miami-Dade County Public Schools](#) (Adobe PDF)

FL, 2003, 6,395 students, urban public schools, mixed ethnicity

[Moore Independent School District](#) (Adobe PDF)

OK, 2001, 1,035 students, urban public schools, mixed ethnicity

[El Paso Independent School District](#) (Adobe PDF)

TX, 2001, Algebra I, large, urban schools; 90% Hispanic

[Canton City Schools](#) (Adobe PDF)

OH, 2001, Algebra I, study of 293 students, large, urban schools; ~1/3 African-American

[The Colony High School](#) (Adobe PDF)

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TX, 2000, Algebra I, large, suburban school, 76% Caucasian

Lewisville North High School (Adobe PDF)

TX, 2000, Algebra I, suburban school, 70% Caucasian

Denver Public Schools (Adobe PDF)

CO, 2000, Algebra I, summer school, study of 233 students, large, urban schools;
~50% Hispanic

San Francisco Unified School District (Adobe PDF)

CA, 2000, Algebra I, summer school, study of 212 students, large, urban schools,
mixed ethnicity

El Paso Independent School District; El Paso, TX (Adobe PDF)

TX, 2000, Algebra I, large, urban school; 90% Hispanic

Milwaukee Public Schools (Adobe PDF)

WI, 1997, Algebra I, study of 94 students, large, urban schools, largely African-
American

Pittsburgh Public High Schools (Adobe PDF)

PA, 1995, Algebra I, study of 454 students, large, urban schools; ~50% African-
American

References to current research on Cognitive Tutor can be found at
<http://www.learnlab.org/research/papers.php> and
http://www.carnegielearning.com/approach_references.cfm.

- 4. To what extent do the program's theoretical framework, diagnostic assessments, instructional design, and content align with your school's overall vision for mathematics education? *NCTM 1.3, 5.2***

VENDOR RESPONSE:

Carnegie Learning, Inc. is a third-party provider of curricula and professional development services and will work to help each individual school realize its vision for mathematics education.

Professional Development (*NCTM Topic 4: Organizational Structure of the Intervention*)

5. **To what extent does the program provide rigorous professional development that contributes to a teacher's robust understanding of program framework, instructional technique, and use of materials? *NCTM 4.3***

VENDOR RESPONSE:

Carnegie Learning is committed to innovation and leadership in mathematics education, starting with our award-winning Carnegie Learning curricula and extending to quality training, support, and professional development for educators.

Carnegie Learning's Professional Development for Implementation of the Cognitive Tutor has been structured to address course methodology, student discourse, assessment, pacing and planning. An emphasis is placed on aligning teaching to learning mathematics with a commitment to provide teachers with the experience, insight and support to grow as more reflective practitioners.

Our programs integrate the standards and guidelines issued by national, state, and local educational entities. Our goal is to provide teachers with the experiences needed for them to develop as innovators who work from a solid understanding of algebraic and geometric concepts. Carnegie Learning's curricula are powerful tools for teaching and learning mathematics and have been shown to greatly improve student motivation, engagement and achievement.

During professional development, we focus on specific goals that are designed to support success in the classroom. These objectives include:

- Creating an environment that encourages discourse and student communication of mathematics

- Integrating technology effectively into the instructional process
- Improving teacher capacity including both content and pedagogical knowledge

To ensure that every implementation yields successful results, we offer comprehensive Professional Development programs delivered by our team of Managers of School Partnerships and Certified Implementation Specialists. At every opportunity the members of the team strive to address the challenges and pedagogical concerns faced by teachers implementing the Carnegie Learning curricula.

6. To what extent does the professional development aid teachers' growth to conduct formative assessment by deliberately reflecting on practice and student performance following each lesson?

VENDOR RESPONSE:

Carnegie Learning's Professional Development for implementation address the teachers' growth in three different ways: modeling the use of formative assessment questions to understand what learners know and can do, explicitly call out the formative assessment tools provided in the Teacher's Implementation Guide and Cognitive Tutor Software, and analysis of Teacher's Toolkit Reports.

Participants in our professional development seminars experience software and textbook problems as learners. Carnegie Learning's facilitators, Managers of School Partnerships, are pedagogical experts who model the questioning strategies that we expect teachers to use in the classroom. At the close of each lesson, the facilitators reflect with the participants on the questions that were asked to drive the understanding of the mathematics. The facilitator moves are made explicit to the participants.

The Teacher's Implementation Guide (TIG) provides teachers with reflective tools for each lesson. Formative assessment questions, essential questions, and guiding questions are provided for each lesson. Teachers in PD look at these tools and discuss how they can use what is provided to and inform their instruction. On day 3 of the initial professional development session, teachers will use these tools to guide their lesson planning process.

The Teacher’s Toolkit is the Cognitive Tutor’s management tool for teachers. In the Teacher’s Toolkit, the teacher can generate reports about students’ progress, time on-task, skill mastery or lack of mastery, and frequency of errors and hint requests. These reports can be run on a class level or student level. During the professional development, teachers will look at authentic student data from the Toolkit reports and analyze the student’s successes and challenges. Teachers then discuss what intervention strategies could be implemented to build on the successes and address the challenges. The formative data provided by the Teacher’s Toolkit is a powerful tool for the teachers, and significant professional development time is dedicated to ensuring that they understand how to use it well.

7. To what extent does the professional development incorporate coaching visits?

VENDOR RESPONSE:

Professional Development for Implementation Plan Summary

Carnegie Learning is committed to ensuring success in mathematics. In an effort to define roles and responsibilities of both partners, the Implementation Plan summarizes the tasks that are critical to a successful implementation, including Initial Getting Started Training in the Summer Schedule, In Classroom Support, Leadership Support, Instructional Coaching and Using Data to Inform Instruction, and Results.

To assure a smooth implementation, Carnegie Learning has developed a comprehensive plan for an entire school year. There are four phases to the Carnegie Learning Implementation:

Phase 1	Phase 2	Phase 3	Phase 4
Initial Getting Started in Summer Schedule	In-Classroom Support and Monitoring of Fidelity	Instructional Coaching and Using Data to Inform Instruction	Results – Analyzing Results and Reporting Achievement

Implementation Phases

To assure a smooth start-up and implementation, Carnegie Learning's comprehensive Implementation Plan for a school year defines specific actions within each phase.

Below are the key steps for implementation across each phase that can be used as the basis of a plan and checklist for site implementation. We recommend that each school receiving Carnegie Learning for the first time is given this outline as part of training.

Phase 1: Initial Getting Started Phase for Summer Schedule

Outcomes

During professional development, we focus on specific goals that are designed to support success in the classroom. These outcomes include:

- Creating an environment that encourages discourse and student communication of mathematics
- Integrating technology effectively into the instructional process
- Improving teacher capacity including both content and pedagogical knowledge
- Using data to inform instruction
- Analyzing results and reporting achievement

The Professional Development Solutions proposal will determine the depth and breadth of content that we are able to unpack with the participants. Following a recommended progression of professional development workshops as outlined below for a blended curriculum implementation yields success for the district, the administrator, the teacher and the student in the Carnegie Learning classroom.

Summer Leadership Seminar (Building Principals)

Two sessions can be provided during the summer. Administrators participating in the Summer Leadership Seminar will be able to understand the Carnegie Learning research base and instructional model. They will review the Cognitive Tutor® to provide a conceptual overview of how it is intended to work, the resources required to make it effective, and the outcomes that are expected for students to achieve, aligning Carnegie Learning to curriculum standards and standardized tests. Administrators will review the diagnostic reports for continuous assessment, placement, and monitoring and develop their role in understanding what to expect in a Walk-Through of a Carnegie Learning classroom.

Carnegie Learning Initial Program Training for New and Veteran Teachers

Three initial program training sessions will be provided in Algebra 1, Geometry and Algebra II. Veteran teachers will develop a deeper understand of the instructional expectations for a successful implementation and learn the best practice teaching strategies that must be implemented to achieve a highly effective implementation. New teachers learn instructional planning and pacing, how to use data in the toolkit reports to inform daily instruction and how to assess and track progress.

Phase 2: In-Classroom Support and Monitoring of Fidelity in the Classrooms

Goals and Objectives:

Professional development coaching opportunities allow insight about how teachers are implementing the Carnegie Learning curriculum and brining ongoing support to the classroom. Through one-on-one conversations, as well as group discussions, Carnegie Learning’s Manager of School Partnerships will bring their mathematical expertise into the classrooms they visit and share best practices with teachers and administrators.

With these objectives in mind, the Manager of School Partnerships will:

- Observe classrooms and or labs to provide relevant feedback to teachers,
- Assist in lesson planning and pacing to meet the mathematical goals of the curriculum,
- Analyze Teacher’s Toolkit reports to analyze data to inform instruction,
- Make classroom specific recommendations to strengthen implementation,
- Provide administrators with implementation feedback action planning, and
- Review common assessment tools, such as Carnegie Learning’s test generator to develop a set of common assessments for 2010.

Teachers will receive five days of onsite support from Carnegie Learning offer 5 in-classroom support days per teacher.

Phase 3: Instructional Coaching and Follow Up

Leadership Seminars

We will provide three sessions each for building administrators as a continuation of the work begun during the summer. The focus continues on data analysis, accountability, sharing of best practices, and monitoring of student achievement.

Monthly Professional Development Meetings

Monthly ongoing professional development meetings will provide the opportunity for teachers to collaborate through modeling best instructional practice and sharing student work, successful pacing ideas, effective ways to grade, lesson study, grouping strategies, and best ways to collaborate as a team.

Phase 4: Results Phase

Evaluation is an ongoing element of a *Carnegie Learning* Implementation Plan. At the end of the year, it is recommended that the evaluation include the evaluation of the total implementation, student achievement results, and action planning for the next year.

While the evaluation of student and achievement data is embedded in the process year round, much as we use formative assessment and progress monitoring to guide instruction, a final year end progress review will assist in overall program evaluation and provide critical feedback for subsequent support and professional development.

- 8. To what extent does the professional development facilitate establishment of an engaged learning community?**

VENDOR RESPONSE:

During Professional Development, teachers participate in activities and hands-on experiences with lessons from the textbook and sections from the Cognitive Tutor. The workshops emphasize Learning by Doing™ where the role of the teacher is to facilitate student interaction, communication and problem solving. Carnegie Learning facilitators model a learner-centered, standards based classroom. Teachers are grouped with their peers and are expected to work collaboratively on all tasks and to make their learning visible through presentations and explanations. Through these activities, many teachers

gain a new understanding about their colleagues and a new perspective on the importance of working collaboratively.

9. To what extent does the professional development prepare teachers to guide student attainment of conceptual understanding of mathematics?

VENDOR RESPONSE:

Carnegie Learning was founded and is led by distinguished cognitive psychologists and has a wealth of knowledge from the cognitive sciences about how people learn. The Educational Services team has drawn on this knowledge in designing learning opportunities for teachers. We believe that our professional development work-shops should be based on the same learning principles.

During Professional Development, teachers will participate in activities and hands-on experiences with lessons from the Cognitive Tutor. The workshops emphasize Learning by Doing™ where the role of the teacher is to facilitate student interaction, communication and problem solving.

Throughout the sessions, teachers learn best practices based on the latest research in *How People Learn* and are provided with the opportunity to see them in practice both from the perspective of a student and as a teacher.

- Learning with understanding is facilitated when new and existing knowledge is structured around the major concepts and principles of a discipline.
- Learners use what they already know to construct new understandings.
- Learning is facilitated by use of meta-cognitive or reflective strategies that assist learners in identifying, monitoring, and regulating their cognitive processes.
- Learners have different strategies, approaches, patterns of developed abilities, and learning styles because of interactions between their opportunities to learn and their prior experiences.
- Learning is situated in activity and is shaped by the context and culture in which it occurs.
- Learners' motivation to learn and their sense of self affect what they learn, how much they learn, and how much effort they will put into learning.

- Learning is enhanced through socially supported interactions.

How People Learn: Brain, Mind, Experience and School

Brandsford, J.D., Brown, A.L. & Cooking, R.R. (Eds) 1999, National Academy Press

10. To what extent does the professional development support teachers in becoming mathematics education leaders within their schools?

VENDOR RESPONSE:

For teachers who have successfully implemented Carnegie Learning’s curricula in the classroom, there is an opportunity to participate in a specialized professional development to become one of Carnegie Learning’s Certified Implementation Specialist (CIS).

CISs are current or former classroom teachers and Cognitive Tutor users who have successfully implemented the curricula within their classes. To become certified, each must attend an Implementation Specialist Training and, through a robust evaluation process, become certified and contracted to serve as facilitators for Carnegie Learning’s professional development offerings on an as needed basis. Each CIS is required to participate in an annual recertification session so that he or she is always on the cutting edge of advancements in Carnegie Learning’s products and training methodology. They are evaluated regularly on multiple criteria relating to the facilitation of sessions. These individuals are dedicated to helping teachers implement best practices for teaching and learning.

Our CISs are district leaders who serve as our ambassadors in the schools. Teachers who participate in the Implementation Specialist Training session have a unique opportunity to learn and share best practices with the most skilled implementers. This unique learning experience builds leadership capacity within the district and a strong voice for teaching and learning in the schools.

11. To what extent does the professional development prepare teachers to advance student thinking?

VENDOR RESPONSE:

By incorporating the best practices from *How People Learn* throughout the professional development, the facilitators model the type of interactions that advance student

thinking. By making the facilitator's moves explicit through reflection and discussion, the group has an authentic experience to replicate when they return to the classroom.

During Initial Professional Development, the teachers participate in a collaborative exercise that addresses how to ask questions to clarify and extend student understanding. The teachers participate in mathematical presentations and then reflect on how student communication strengthens and clarifies student understanding of the mathematics. These experiences provide teachers with strategies on facilitating student discourse in the mathematics classroom and an understanding of why it is so critical to student learning.

12. To what extent does the professional development foster a sense of purpose and commitment to the instructional mission?

VENDOR RESPONSE:

The overarching goal of each and every professional development session that Carnegie Learning provides is to strengthen the teachers' ability to provide students with access to a deep understanding of mathematics. This goal is reiterated in every aspect of the session. When teachers are engaged as learners, they are required to think deeply about the mathematics and how it is related to prior knowledge and experiences. The teachers use graphing calculators to efficiently create and connect representations and reflect on the value of using this technology with their students. When they are engaged as facilitators, teachers share their best practices for facilitating student discourse and discuss how student communication deepens understanding. As planners, the teachers analyze the connection between assessment, planning, and pacing, and how ongoing assessment enlightens the teachers' understanding of what students know and can do. Through each day of professional development, teachers have an opportunity to process what it means for a student to have a deep understanding of mathematics and to reflect on what they need to do to provide this opportunity for all of the learners in their classroom.

13. To what extent does the professional development incorporate reading materials that provide teachers with rigorous exposure to current research in teaching and learning?

VENDOR RESPONSE:

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Throughout the Initial Professional Development sessions, teachers are exposed to current research in teaching and learning. The training facilitators reference the following books throughout the session: *How People Learn* (Bransford, 1999), *Adding it Up* (Kilpatrick, 2001), and *The Teaching Gap* (Stigler and Hiebert, 1999). Additionally, teachers are provided with an article that summarizes current research in teaching English Language Learners; a bibliography of titles references is included for teachers' further study.

Additionally, our Managers of School Partnerships are pedagogical and content experts who stay linked into current research in teaching and learning. For ongoing professional development sessions, the MSPs can customize sessions around current research to provide teachers with a rigorous experience.

14. To what extent will teachers enjoy and engage in the professional development?

VENDOR RESPONSE:

The model for our Initial Professional Development Seminar is to engage teachers in three ways: as a learner, as a classroom facilitator, and as a planner. Teachers will move through these three roles throughout the session as they gain content knowledge, new strategies for facilitation, and a structure for continuous assessment and planning. The participants will have opportunities to share their own best practices and to learn from their peers. The sessions are lively as teachers Learn by Doing®.

Teachers complete online evaluations at the end of each professional development session. Some of the comments that have been made by teachers on these evaluations include:

“This was one of the most beneficial trainings that I have attended. [The trainer] was very prepared and able to provide meaningful activities. It was obvious that he is an expert at using the Cognitive Tutor in his personal classroom.”

Tammy Gilbert, Moorefield High School, WV

“I thought the presentations were effective, fun, and “user-friendly”. If I feel this motivated, imagine how my students will react to this!!”

Suzy Hall, Hunter Middle School, TN

“Practical, hand-on training that has reduced my stress level and made me feel ready to begin teaching on Day 1. Bravo.”

Nancy Maple, Lofton High School, FL

“If you attend one curriculum training this school year, make it this one!”

Jim Capecci, Keithley Middle School, WA

15. To what extent does the professional development align to the KDE Professional Development Standards?

VENDOR RESPONSE:

By using a learner-centered approach that addresses content knowledge, facilitation tools and strategies, questioning, formative and summative assessment, and lesson planning, Carnegie Learning’s professional development programs align fully to the KDE Professional Development Standards.

Diagnostic and Formative Assessment (<i>NCTM Topic 1: Diagnostic</i>)
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16. To what extent does the program prepare teachers to diagnose, with precision, a student’s level of readiness for learning mathematics? *NCTM 1.2*

VENDOR RESPONSE:

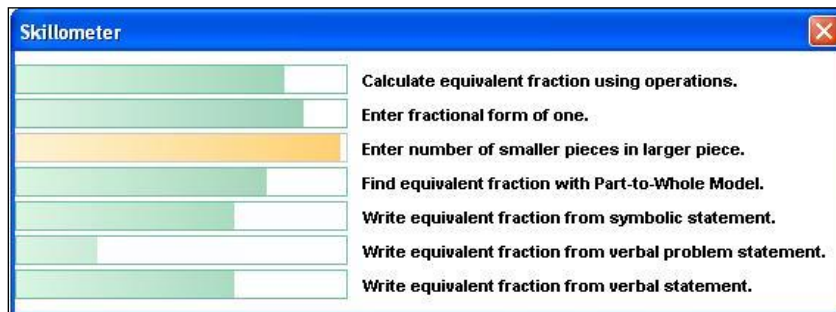
The Cognitive Tutor software is the most advanced formative assessment tool on the market today. Students are continually, dynamically assessed on course objectives as they complete Cognitive Tutor activities. Every action (textfield entry, menu choice, button press, etc.) that a student takes in the Cognitive Tutor software is associated with one or more cognitive skills. Each section of the curriculum contains a list of monitored skills, and the student’s progress with respect to those objectives is displayed on screen through the “Skillometer.”

The Skillometer, shown below, is a fluid, real-time, and continuous assessment tool. Units typically have multiple sections, and each section contains a number of skills, which represent major educational objectives.

While keeping students aware, engaged, and positive about their math experiences, it also provides immediate feedback to teachers. This constant visibility and ever-moving

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measure of student progress allows students and their teachers to see which skills are mastered more quickly and which still need to be mastered with additional teaching.



The Skillometer motivates students to do their best work and master skills.

Progress, with respect to the skills represented in the Skillometer, controls problem selection and pacing for each individual student. When a student completes a problem, the Cognitive Tutor® chooses a problem from its database that best matches the set of the skills that the student needs to master (and that involves the fewest skills that the student has already mastered). When a student has demonstrated mastery of a particular skill, the skill bar for that skill will turn gold. When all skills in a section are mastered, the student automatically goes on to the next section, which introduces new skills to be mastered.

If a student is not making adequate progress on a skill, despite having completed a large number of problems, the software will flag that skill as “un-mastered” and highlight those un-mastered skills in teacher reports. These flags allow teachers to target exactly where to intervene with individual students. In addition, the students’ responses to problems feed into a database that allows teachers to see exactly where their students are individually or collectively having problems.

Teachers can also visually review strand achievement levels for each of their students on the visible Skillometer, and identify those who need a personal touch, a kind word, or a human voice in addition to more targeted time on task.

There are several advantages to this model of assessment. Because assessment is integrated with instruction, students do not lose valuable instructional time to planned assessments. Incorporating assessment into instruction also ensures that the assessments are authentic and relevant to the instructed curriculum. The use of a

cognitive model allows the system to present students with complex problem-solving tasks and still diagnose student knowledge on individual skills.

17. To what extent does the program provide systems for organizing student data for the purposes of instructional design and for anecdotal reporting in ways that both teachers and parents may understand? *NCTM 1.4*

VENDOR RESPONSE:

Carnegie Learning® Teacher's Toolkit maintains student histories and makes them instantly available to teachers via pre-formatted reports including both individual and class-level reports of student data. With this data, teachers can track real time progress and reporting in math. All reports can be adapted for integration with school, district, and state databases and reporting. Toolkit reports cover a variety of information including:

- The View Class Progress report uses drop-down menus that allow teachers to easily select both the class and the curriculum, and see at a glance how each student or class is progressing.
- The Class Summary report shows each student's current position within the curriculum and how many units each student has left to complete before mastering a skill.
- The Detailed Student report displays summary information for each student, e.g., number of problems solved, average time per problem, and average help requests per problem.
- The Skills Alert report shows skills that are more difficult for individual students and/or the class to master.

18. To what extent does the program prepare teachers to fully utilize formative assessment to design data-driven instruction targeted at each student's zone of proximal development?

VENDOR RESPONSE:

The Cognitive Tutor's mastery-based approach is designed so that students are always working in their zone of proximal development. Advanced students will quickly and correctly complete problem elements that they already know (or easily learn), and the system will choose problems that involve elements that these students have not already

mastered. Students who are struggling with particular skills will receive problems and instruction targeted at exactly those skills.

The teacher's role in this process is very important. Through Teacher Toolkit reports and through monitoring students' Skillometers and questions that students ask in the computer lab, teachers can get a complete picture of students' state of knowledge. Individual student and class reports help teachers to structure whole-class and individual instruction in response to students' strengths and weaknesses, as demonstrated through the software.

- 19. To what extent do the formative assessment mechanisms allow a teacher to explore student progress in different domains of learning (i.e. conceptual/critical thinking as it relates to supporting procedural/skill performance)? [NCTM 1.1](#)**

VENDOR RESPONSE:

Cognitive Tutor tasks are designed to provide practice on procedures in the context of conceptual understanding. This approach leads to better retention and generalization for students. Teachers can monitor individual skill progress through tools like the Skillometer and unmastered skills reports. They can also monitor overall problem solving and strategic thinking skills through the individual student reports, which show student progress on the problems as a whole.

Instruction and Differentiation (NCTM Topic 2: Instructional Activities)

- 20. To what extent does the program require that students engage in sustained hard thinking in order to construct concepts that build facility with mathematical skills?**

VENDOR RESPONSE:

Each problem that a student completes in the Cognitive Tutor software is task-persistent; the student must complete the problem correctly before s/he can move onto the next problem. While students can use hints to guide them if they are struggling with a concept, the Skillometer tracks the number of hints used on each problem and adjusts instruction to include more problems when to address the area of weakness. As a result, students are required to think a problem through to the end, connecting the different representations presented in any given problem.

In the textbook, each problem begins with a scenario that places a context around the mathematical ideas that are explored in the section. Teacher then facilitates the students' interaction with the mathematics, allowing them to build on prior knowledge and experiences to create new understandings. At the conclusion of each lesson, students present their mathematical findings, and the teacher provides closure on the lesson to ensure that all students understand the mathematical goals of the lesson. In both the textbook and the software, students are responsible for Learning by Doing®.

- 21. To what extent does the program allow students to experience and internalize the idea of *quantity* in a variety of settings presented by the teacher with a progression of diminishing support in order to guide thinking from concrete/unitary to abstract/composite? *NCTM 2.5***

VENDOR RESPONSE:

Carnegie Learning® Bridge to Algebra is designed as the course taken immediately prior to an Algebra I course. It can be implemented with students who lack the prerequisite knowledge necessary for success in Algebra I. The first part of Carnegie Learning® Bridge to Algebra focuses heavily on numeracy. Students work with multiple representations such as models and number lines to develop a strong conceptual understanding of fractions, decimals, and percents. Students use that conceptual knowledge to develop an understanding of algorithms used to operate on and convert between various numbers. Students are also introduced to ratios and proportions, signed numbers, exponents, roots, and absolute value.

Throughout all of Carnegie Learning® Math Curricula, the mathematical concepts are placed in context to provide them with opportunities to use their prior knowledge and experiences to make sense of a concept. Students are required to write their answers in complete sentences, applying the appropriate units of measurement. This process provides students with an opportunity to make sense of their answer, determining if it is appropriate in the context and the abstract concept.

- 22. To what extent can the program be flexibly adapted to meet the instructional needs of students who are at a variety of readiness levels?**

VENDOR RESPONSE:

Carnegie Learning Cognitive Tutor® software provides students with highly individualized, self-paced instruction. Our unique cognitive modeling technology is

developed around an artificial intelligence model that identifies strengths and weaknesses in each individual's understanding of mathematical concepts and procedures, customizes prompts to focus on areas where the student is struggling, and presents new problems that address specific concepts that have not yet been mastered.

The Cognitive Tutor® software stimulates intellectual curiosity and engagement, while improving motivation and self-regulated learning. The software individualizes instruction and continuously assesses student responses to create a customized instructional path, ensuring that students spend more time on concepts they don't know and less time on topics that they have already mastered. The artificial intelligence model intuits where a student needs help, and provides just in time hints and help as a student proceeds through the program.

Cognitive Tutor® Software is compatible with the screenshot reader feature of a third-party product, Read&Write 8.1 Gold. Allowing students that need read aloud audio the ability to have the text on the screen read to them.

23. To what extent is the intervention instruction carefully linked with the results of each student's diagnostic assessment? *NCTM 2.1*

VENDOR RESPONSE:

If a teacher chooses to include a pre-test in a customized curriculum, the teacher can opt to make this pre-test prescriptive. A student's performance on a prescriptive pre-test impacts the Skillometer and how it measures the student's skills. For example, when a student is highly successful on a particular skill in the pre-test, when that student enters a unit of instruction on this skill, the Skillometer will pre-set their skills at a higher level. Therefore, the student does not have to complete as many problems to demonstrate mastery of that particular skill. This allows students to accelerate through the curricula to units of instruction that are more challenging for them.

It is important to emphasize that the instructional intervention is itself a diagnostic assessment, so that the Cognitive Tutor is continually diagnosing student knowledge and adapting to the student's current state of knowledge.

24. To what extent are formative assessments embedded within ongoing instructional activities? *NCTM 2.3*

VENDOR RESPONSE:

Please reference the response to question 16.

25. To what extent can the program be flexibly adapted to meet the optimal instructional pace of the individual?

VENDOR RESPONSE:

Please reference the response to question 22.

26. To what extent does the program provide specific remediation strategies for recognizing and addressing *common* student misconceptions?

VENDOR RESPONSE:

The Cognitive Tutor software has been developed to identify common student misconceptions. The software provides individualized instruction in the form of “Just–In-Time” help when it recognizes a common student error. This feedback is one of several ways in which the Cognitive Tutor software individualizes instruction. If a student makes a recognizable error, for instance, the Cognitive Tutor software will indicate why the answer is incorrect or pose a thought-provoking question to redirect the student’s reasoning.

The Teacher’s Implementation Guide provides the teacher support in recognizing and addressing common student misconceptions by calling them out in each lesson. In addition to highlighting these misconceptions, the TIG provides the teacher with guiding questions that can be used to address these misconceptions.

27. To what extent does the program encourage the development of students’ abilities to communicate their mathematical ideas?

VENDOR RESPONSE:

Carnegie Learning’s collaborative classroom environment promotes discourse, group work and depth of understanding that emphasizes 21st Century Learning Skills. Carnegie Learning’s classroom design integrates these key skills into the instructional process, and provides tools for teachers to use in facilitating this classroom model:

- Decision Making and Problem Solving
- Creative and Critical Thinking
- Collaboration and Communication

- Intellectual Curiosity/Finding, Structuring and Evaluating information
- Self Correction
- Life Long Learning

Research has shown that we learn based on prior knowledge, and making connections to what we already know. Examples abound in Carnegie’s textbooks – showing students how to make the connections to real world applications with which they are familiar, and weaving those points of connection throughout the program. Groups discuss mathematics, create, reflect, present, and defend their ideas to each other and to the group. While the teacher guides the instructional process, often the instructor functions more as a facilitator than as a traditional “stand and deliver” lecturer.

28. To what extent is the mathematical content appropriately focused (according to the National Council of Teachers of Mathematics *Focal Points*) to deepen understanding of key concepts?

VENDOR RESPONSE:

Carnegie Learning® Bridge to Algebra, Algebra I, Geometry, and Algebra II curricula are aligned to the five content strands of the standards set by the National Council of Teachers of Mathematics. We use real-world situations in our math problems. We help students see how math is relevant in our lives. Our math problems are designed to emphasize connections between verbal, numeric, graphic and algebraic representations.

29. How can this program be used or expanded to accommodate all the tiers of intervention associated with RtI under IDEA 2004?

VENDOR RESPONSE:

Tier 1: Universal

You can implement Carnegie Learning Curricula as your universal curriculum for all students. Our core curriculum model helps students obtain a deep conceptual understanding of the math. Students spend more time learning working on engaging math programs in groups and independently.

Implementation Model: A daily instruction model where students spend more time being active learners during class periods as they work in small groups or independently

to solve engaging math problems. Each student is given a Carnegie Learning Consumable Text that they can write in, take notes in, highlight key data in a problem, and show his/her work to solve a problem. Teachers encourage and facilitate classroom discourse about mathematics. Students are expected to regularly prepare, present, and discuss solutions to math problems.

Tier 2: Strategic Intervention

We can target students' skill deficits in our Cognitive Tutor Software. It is the most powerful mathematics software for differentiating instruction. Each student receives a truly individualized learning experience because the software adapts to their learning needs. Students are also provided support while they learn in the forms of just-in-time feedback and hints. They're designed to be very specific to help a student persist to solve the math problems.

Implementation Model: Provide supplemental instruction via Cognitive Tutor software. Assign the curriculum to students and based upon their knowledge and performance the software will present problems to address student weaknesses. Alternatively, teachers can selectively assign units as needed for practice, reteaching or reinforcement as needed in addition to instruction received from the core curriculum.

Tier 3: Intensive Intervention

At-risk students need more time and practice to master math skills. We provide teachers with the ability to create a custom curriculum sequence to target students' weakest skills. We also offer interactive review sessions for students who need to refresh their understanding of material they've studied previously. We have additional print materials, like a Homework Helper to extend instructional time into the home. Each homework helper volume contains instructions so parents can assist their child if needed.

Implementation Model: Additional daily instruction leveraging both Carnegie Learning Texts and Cognitive Tutor Software.

Example: Students needing an intensive intervention are enrolled in a math support class and Algebra I class concurrently. The Math Support class can address math fundamentals and deepen math understanding required to progress in Algebra I.

30. To what extent will teachers and students enjoy and engage in the teaching of this program? *NCTM 2.6*

VENDOR RESPONSE:

Both anecdotal reports and field research have shown that both teachers and students enjoy using Cognitive Tutor. In a randomized field trial in Moore, Oklahoma, students in Cognitive Tutor classes were found to be more confident in their ability to do mathematics and to perceive mathematics as more useful than students who had completed a traditional curriculum.

The Carnegie Learning Web site provides video testimonials describing their experience implementing our solutions. Please visit:

http://www.carnegielearning.com/video_vault.cfm

31. To what extent are the student materials and technology user-friendly and developmentally appropriate?

VENDOR RESPONSE:

The Cognitive Tutor software has been designed to be easy for students to use. At any time, students can ask for hints. Hints are contextual: they refer to specific problem content, not just general solution methods, and they are responsive to the student's particular approach to a problem, so that different students will get different hints, depending on how they approach the problem. The software also includes interactive examples, which guide students step-by-step through an example problem. In addition, we can offer 24/7 online help (through a chat and whiteboard interface), so that students can ask a tutor for assistance, if they are using the tutor outside of the presence of the teacher. Language, contexts and mathematical content are all designed to be developmentally appropriate for students. Lexile scores for our curricula are as follows:

Bridge to Algebra : 920

Algebra 1: 910

Geometry: 840

Algebra 2: 1000

Summative Assessment (*NCTM Topic 3: Post assessment*)

- 32. To what extent do summative assessments illustrate the degree of instructional efficacy by identifying aspects of student progress over time? *NCTM 3.1***

VENDOR RESPONSE:

Summative assessments report student progress on the mathematical strands covered in the course. Teachers can also look at overall pre- to post-test improvement and examine performance on individual questions for each student and for the class as a whole.

- 33. To what extent do summative assessments generate practical data in a timely manner that may be used to guide further instruction? *NCTM 3.2, 3.3***

VENDOR RESPONSE:

Within the software, summative assessment results are available immediately upon completion.

Logistics (*NCTM Topic 2: Instructional Activities; Topic 4: Organizational Structure of the Intervention*)

- 34. What are the grade levels targeted by this program? *NCTM 4.1***

VENDOR RESPONSE:

Carnegie Learning® Math Solutions are designed to meet the needs of students in grades 7-12 with a variety of skill levels from gifted to special education. Our solutions include:

Carnegie Learning® Bridge to Algebra

Carnegie Learning® Algebra I

Carnegie Learning® Geometry

Carnegie Learning® Algebra II

Carnegie Learning® Integrated Math I, II, and III

35. What is the cost of training? *NCTM 4.2*

VENDOR RESPONSE:

Initial Training and ongoing Professional Development Seminars each cost \$2000 per day. Our customized implementation framework recommends 3 days of initial training, 2 Professional Development Seminars, and intensive In-Classroom Support with Instructional Coaching at differentiated price structures: 1-3 days at \$1600 per day; 4-9 days at \$1400 per day; and 10+ days at \$1250 per day.

PD Description	Location	Duration	Unit	Notes
Initial Product PD	Onsite	2 Days/25 teacher limit	\$2,000	Two day recommended
Instructional Coaching	Onsite	5 days per teacher in Phases 2 and 3	\$1400 per day	Each teacher will have instructional coaching in Phases 2/3

36. What is the cost of materials? *NCTM 4.2*

VENDOR RESPONSE:

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The pricing provided below are based upon Carnegie Learning’s per student pricing model. **However, additional pricing models are available.** In all cases, volume and term discounts apply.

Item Description	Quantity	1 Year Unit License Cost	3 Year Unit License Cost
Software License	1-249	\$40.00	\$40.00
	250-499	\$28.00	\$23.80
	500-999	\$24.00	\$20.40
	1000- 2499	\$23.20	\$19.72
	2500+	\$22.40	\$19.04
Support & Maintenance	1	\$5.20	\$5.20
Carnegie Learning™ 24/7 Math Help	Per hour/per student	\$14.95	\$14.95

37. What Materials and/or software are included in the cost? *NCTM 4.2*

VENDOR RESPONSE:

- Student Materials:
 - Cognitive Tutor® Software
 - Student Texts: Student Assignment Book; Homework Helper

- Teacher Materials:
 - Teacher's Implementation Guide
 - Teacher's Resource and Assessments Book
- Software Implementation Guide
- Student License for the Cognitive Tutor® software
- Carnegie Learning® 24/7 Math Help
- Access to Carnegie Learning® Teacher's Toolkit, a simple to use learning management system for enrolling students and monitoring their progress.
- Professional Development & Training
- Access to Carnegie Learning® Resource Center for materials like correlation documents, implementation guides, etc.
- Technical Maintenance & Customer Support

38. What are the suggestions and costs for additional materials? *NCTM 4.2*

VENDOR RESPONSE:

No additional materials are required for a full implementation of our textbook or software.

39. What is the recommended group size? *NCTM 4.1*

VENDOR RESPONSE:

Carnegie Learning curriculum is adaptive to any classroom size. Normally the average class size ranges from 30-40 students with individual group work ranging from 2-5 students per group.

The Teacher's Implementation Guide recommends when to group students and the size of each group as the class works through the pedagogy of the program.

40. How can this program be used to benefit additional struggling students not directly participating in the intervention?

VENDOR RESPONSE:

Carnegie Learning Cognitive Tutor® software provides students with highly individualized, self-paced instruction. Our unique cognitive modeling technology is developed around an artificial intelligence model that identifies strengths and weaknesses in each individual's understanding of mathematical concepts and

procedures, customizes prompts to focus on areas where the student is struggling, and presents new problems that address specific concepts that have not yet been mastered.

Cognitive Tutor® Software is compatible with the screenshot reader feature of a third-party product, Read&Write 8.1 Gold which allows those students with reading disabilities to have the online text read aloud to them

In addition, students may access the software outside of school hours. Therefore, students who are not directly participating in the intervention can be provided with access to the software to support the learning in their mathematics classes.

41. What is the recommended lesson length? *NCTM 4.1*

VENDOR RESPONSE:

Carnegie Learning’s curricula have been implemented in a wide-range of models, and we are committed to helping customers create a model that fits their goals for instruction.

For implementations of our Blended Solution (textbook and software), Carnegie Learning recommends that teachers spend 60% of their instructional time facilitating lessons from the textbook and the remaining time facilitating student interactions on the software.

For implementations of our Cognitive Tutor® Software, Carnegie Learning recommends that students spend at least 1 hour per week on the software.

42. What, if any, is the total recommended pull-out time (missed regular class time) per student? *NCTM 4.1*

VENDOR RESPONSE:

Carnegie Learning’s implementation model is flexible to fit the needs of the students in a school or district. The textbook and/or Cognitive Tutor Software can be used as a core curriculum, within scheduled class time, or as a supplement to what is already being used.

43. Since mathematics intervention is intended to be supplemental to the core mathematics program, is the mathematical content of the intervention program appropriate for accommodating each student’s foundational learning needs and

aligned to a subset of the *Kentucky Core Content for Assessment, Kentucky Program of Studies, National Council of Teachers of Mathematics* standards, and the school's overall vision for mathematics education, rather than being an attempt to cover all topics? [NCTM 2.2](#)

VENDOR RESPONSE:

The Cognitive Tutor software can be aligned to meet the needs of a particular class, a small group of students, or an individual student. In the Teacher's Toolkit, there is functionality to create a Custom Curriculum. Teachers can select units of instruction from any of our software titles that they are licensed for to target each student's learning needs.

A powerful feature of the Cognitive Tutor software is the Skillometer, the artificial intelligence that measures students' mastery of a granular set of skills for each section. Based on John Anderson's ACT-R theory of mastery learning, the Skillometer adjusts the software pacing to provide each student with the number of problems that he/she requires to master a given set of skills. This allows students to progress quickly through material that they have previous experience or mastery in and to receive extra practice on the material that they may struggle. This highly individualized approach provides each student with a focused path through the units of instruction that the teacher selects for him/her.