Supporting K–12 Students in Online Learning:

A Review of Online Algebra I Courses

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Acknowledgments

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Executive Summary

The purpose of this report is to provide objective information about the online Algebra I courses available on the market today. Specifically, this report examines six Algebra I courses that students can take totally online, usually for high school credit toward graduation. Online learning has been a growing trend in K–12 education from the 1990s to today. Among the many online courses available to K-12 students, Algebra I courses are among the most popular, representing a relatively mature segment of the online learning market with multiple course providers and high course enrollments. These courses provide insight into online learning for formal education generally, but Algebra I is a worthy object of study in its own right. It is especially important for students to succeed in Algebra I because research has identified it as a "gateway" course that helps predict students' future academic success, including which courses students take and whether they go to college. However, it can be difficult to gather information regarding online Algebra I options available in the marketplace and how these options vary.

This report describes the range of instructional resources, activities, and policies that make up current online Algebra I courses in the context of a systematic review of six online Algebra I course providers: Apex Learning, Class.com, Edgenuity, Florida Virtual School, K12 Inc., and Michigan Virtual School.[1] It can help both consumers and developers of online courses identify high-quality instructional design strategies, with a focus on those that can be used to support students who are at-risk and have been historically disadvantaged or underserved in online learning.

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1 "Online courses" as defined here are teacher-led courses in which 80% or more of the instruction occurs via a Web-based educational delivery system, with the teacher and student separated geographically. They can include both synchronous and asynchronous components, and may be accessed from multiple settings, including school buildings.

Drawing on recent research about online learning and mathematics instruction, the report focuses attention on course characteristics that are most likely to support student learning online. Significant characteristics include course content and structure, instructional approach, media design, and assessment and feedback. Throughout the report, particular emphasis is placed on the needs of struggling students. Emerging research suggests that participation and success in online learning as currently designed and implemented in mainstream educational practices may not be equitable across groups of students. Supporting at-risk student success in online courses may require special consideration and instructional adjustment.

Information about courses was obtained during interviews with course providers and through an independent review of the courseware. Our analysis did not include a review of how teachers used the courseware, nor any correspondence that occurred between students and teachers in an implementation of the course. School-based or local adaptations that may further support the use of online courses in particular settings were also beyond the scope of this study.

Part 1 of the report summarizes practices across course providers and Part 2 presents individual Provider Profiles for each of the six providers.

Research Approach

The research described in this report was funded by the Bill and Melinda Gates Foundation. The research is based on a case study approach that uses a purposeful sample of six online course providers. These six providers both met the study's inclusion criteria and agreed to participate in the study. To be included in the review, providers needed to offer at least one fully online, credit-bearing Algebra I course to middle and secondary students in the 2012–13 academic year; enroll a minimum of 200 students in the Algebra I course in 2012–13; and operate at a large-scale, with courses available at either a state or national level. Providers offering only supplemental materials, or materials designed exclusively for use in a blended environment where students receive the bulk of instruction from a classroom-based teacher, were excluded.

Research analysts first screened possible providers to include in the study and sent invitations to participate to those that qualified. Analysts conducted interviews with participating provider representatives, reviewed providers' websites, and independently reviewed providers' courseware. These research activities allowed us to describe online course content and design, as well as the providers' recommendations for implementation. Although important, the study does not address local implementation of the courseware, including teachers' and students' use of the courseware or local school-based adaptations that may further support the use of online courses in particular settings.

Key Findings

The study yielded important insights regarding the course features across widely available online Algebra I courses from six different providers.
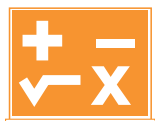
Algebra I Course Content

• **Pressing questions about Common Core alignment.** The course providers profiled in this report describe being active in aligning their courseware to the Common Core State Standards for Mathematics (CCSSM). Key themes of CCSSM highlight the importance of course rigor, focus, intensity, and coherence, but there is not currently a widely accepted method for determining the degree to which instruction addresses these themes. As states continue to adopt the CCSSM, questions about what it means for curriculum and instruction to be aligned to the CCSSM become more pressing. This report introduces an approach to assessing a course's rigor, scope, and focus based on course alignment data. Courseware providers should provide potential users with the right tools, including alignment maps, to facilitate deeper understanding of the degree to which curriculum addresses the CCSSM, even at the topic level. As more schools and districts adopt the CCSSM, this process can be streamlined.

Instructional Approach

• **Wide array of implementation models.** Course providers typically have a number of implementation models that allow varying degrees of local control over software use, teacher role, and administrative policies. Despite (or perhaps due to) all of this activity, it is difficult to determine the share of the market represented by the six participating providers and the number of students they serve. In addition, each vendor described a wide range of potential implementation models and practices. The range of options available and a dynamic, rapidly changing market suggest the importance of consumers of online learning consulting with courseware providers regarding local policies and resources before selecting one provider over another. Established providers typically developed recommended practices for their products based on their experience. In addition to guidance on best practices, providers increasingly offer a range of services that includes staffing, professional development, and support for technology that can be deployed based on local need and interest.

• **Opportunities to more actively support at-risk students.** Our review suggests the online medium presents opportunities to embed practices that can encourage broader participation of underrepresented minorities in online Algebra I courses, such as social-psychological "gap" interventions to help students build confidence and resilience. These interventions are typically brief exercises that target students' thoughts, feelings, and beliefs about school and their own learning/education, often about topics such as students' potential to improve their intelligence or students' sense of belonging and value in school. Although these interventions have demonstrated effectiveness in classroom-based courses, researchers did not find evidence of these practices in online courses. Courses could also build in more supports to improve student regulation skills, such as time-management.

Media Design

- **Opportunities to improve course accessibility.** The learning sciences literature and the National Education Technology Plan emphasize the importance of personalized learning environments to optimize learning for all students. Universal Design for Learning (UDL) guidelines provide a research-based framework for building learning environments that meet the needs of a diversity of learners.[2] At its core, UDL encourages instructional designers to provide learners with a range of alternatives in how the material is presented, how they may respond, and how they may engage with the content. The online Algebra I courses reviewed regularly present students with opportunities to interact with more than one kind of media. However, course providers are still in the early stages of exploring the possibilities of the online medium for supporting UDL, such as allowing students to take more control of the way they choose to express their knowledge. Further adoption of UDL principles would broaden access to online courses for all students.

Assessment and Feedback

- **Robust but evolving assessment and feedback processes.** Research shows that feedback is critical to student learning, and both online courseware and teachers can provide such information to students. All courses reviewed included formative and summative assessments with system-generated feedback on accuracy. However, the data collected by the courseware are still primarily focused on the correctness of the answers that students provide, not the process of how they got there. We expect to see an increase in the amounts and types of timely feedback on student reasoning as courses are revised on the basis of the CCSSM recommendations. Online courseware provides unique opportunities for using and providing student progress and performance in new and engaging ways, such as through graphic representations or through implementation of early warning systems

- **Potential to leverage system data to personalize learning**. We see opportunities to strengthen practices and further incorporate strategies around the use of data for personalization and instructional adaptability. Current data systems have limited capacity to support robust learner analytics, often because necessary data are not captured or stored in a usable format. Stronger technical and data systems would support next- generation courseware that uses artificial intelligence to adapt curriculum scope and pace based on student performance in the system. Student progress data can also be used to automatically tailor content or its presentation to students, as with cognitive tutors.

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2 See http://cast.org/udl/index.html for UDL guidelines.

Implementation

- **On-site and other implementation supports recommended by providers.** While providers should further incorporate supports into courseware, there are inherent limitations to learning at a distance that can serve as a barrier to student success. Course providers are participating in a broader trend in online education to provide additional implementation and user supports to encourage student completion of online courses. Emerging supports include practices such as the use of on-site mentors and frequent teacher-student check-ins. More often than not, these supports are available to all online students rather than tailored to at-risk students specifically. Courseware providers should continue to provide guidance to adopters on place-based supports so that adopters can ensure that students—especially those at higher risk of course failure—receive the on-site support they need.

The key findings from the study suggest features that consumers can look for, and that course developers can build into, the next generation of Algebra I courseware and implementation models to further support student success.

Introduction

Online learning is "a form of distance education that uses the Internet and computer technologies to connect teachers and students and deliver curriculum", (iNACOL 2011) and has been a growing trend in K–12 education from the 1990s to today. Diverse interests are driving the adoption of online learning in education:

• Students may be interested in the opportunity to augment classroom-based course offerings available at their home school, repeat core content, or earn academic credit outside of the traditional school calendar (e.g., at night or during the summer).

• Teachers may be looking for ways to save time, support an increased number of students, and provide more individualized instruction with online content, automated grading support from the system, and diagnostic data.

• District administrators may view online courses as a way to expand the course catalog, reach students unwilling or unable to attend regular school (place or time), include students who have dropped out or are at-risk, or provide instruction in core courses where student enrollment is too low to justify the expense of an additional instructor or in areas where the supply of qualified teachers does not meet the demand. [3]

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[3] Watson et al. (2012, p. 5) indicate that the total number of students taking online courses; attending a fully online, state virtual, or blended school; and participating in blended programs in districts is unknown. Their estimate was triangulated across multiple sources, none of which is comprehensive.

Despite the relative maturity of online courses in the K-12 market, there are few, if any, precise counts of the number of K-12 students enrolled in online learning in the United States. We do have reasonable estimates. One of the best figures available is from the annual *Keeping Pace with K-12 Online Learning* report, which roughly estimates that 5%, or 3 million elementary and secondary students, experienced online learning in the 2011–12 school year (Watson, Vashaw, Gemin, & Rapp, 2012).

For this report, researchers looked at *online courses*, defined here as an alternative—not a supplement—to traditional, classroom-based curriculum, and where the overwhelming majority of instruction, communication, and feedback occurs via the Internet. Many online courses are available for credit, and students who successfully complete appropriate online courses earn credit toward graduation requirements.

Although our focus is on fully online courses, the context in which students take these courses varies substantially based on student needs and preferences, community resources, and school and district policies. Students may participate in an online course across a range of settings, such as in a formal school setting (for example, in a classroom or computer lab), in a community center (such as a library), or at home. Course participation may occur during the regular school day or outside of regular school hours. Some students receive all of their high school credits through so-called virtual or cyber schools (Watson et al., 2011), while the majority of those who participate in online courses do so as a part of a blended program offered by their local district (Queen & Lewis, 2011).[4]

Purpose of This Report

Online courses may be an effective way to expand access to and improve educational outcomes for algebra (Heppen et al., 2012). Algebra tends to be a popular online course option, and one in which it is particularly important that students succeed. However, for many potential consumers of online algebra courses such as students, parents, and educational administrators, it can be difficult to gather information regarding online course options and how these options vary. And the few resources that are available tend to focus on either a single virtual learning environment (e.g., Liu, 2012) or on the "average" efficacy of products (e.g., What Works Clearinghouse) and not the factors associated with success for whom and under what conditions.

This report describes the range of instructional resources, activities, and policies that make up current online Algebra I courses in the context of a systematic review of six online Algebra I course providers: Apex Learning, Class.com, Edgenuity, Florida Virtual School, K12 Inc., and Michigan Virtual School. It is intended for a general audience of researchers, policy-makers, administrators, students, and their parents who are interested in learning more about online learning generally, and about online Algebra I courses in particular. It can help both consumers and developers of online courses identify high-quality instructional design strategies, with a focus on those that can be used to support students who are at-risk and have been historically disadvantaged or underserved in online learning.

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4 In fact, fully online courses may be used as a part of one of several blended learning models described by Stalker and Horn (2012). In the self-blend model, for example, students choose to take one or more classes entirely online to supplement their traditional courses. The online courses may be taken in a formal school setting (e.g., in a computer lab) or off-site (e.g., at home).

Drawing on recent research about online learning and mathematics instruction, the report focuses attention on course characteristics that are most likely to support student learning online. Significant characteristics include course content and structure, instructional approach, media design, and assessment and feedback. Information about courses was obtained during interviews with course providers and through an independent review of the courseware. Our analysis did not include a review of how teachers used the courseware, nor any correspondence that occurred between students and teachers in an implementation of the course. School-based or local adaptations that may further support the use of online courses in particular settings were also beyond the scope of this study.

Why Focus on Algebra I?

Research has identified Algebra I as a "gateway" course that helps predict future course-taking and college attendance (Atanda, 1999; Heppen et al., 2012; Lacampagne, Blair, & Kaput, 1995; National Mathematics Advisory Panel, 2008; Wimberly & Noeth, 2005). Data from both the 1988 and 1992 National Education Longitudinal Surveys (NELS) show that a student completing algebra was twice as likely to go to college as a student who did not complete algebra. Due to this importance, efforts are underway across the country to expand student access to and increase in successful completion of Algebra I (Heppen et al., 2012; Lacampagne, Blair, & Kaput 1995; National Mathematics Advisory Panel, 2008).

Why Focus on *Online* Algebra I?

There are large number of online Algebra I course providers in the K-12 education market, but little is known about how these providers differentiate themselves. Our initial search for online Algebra I course providers found more than a dozen organizations that had been offering online Algebra I for years. In fact, Algebra I courses represent a mature segment of the online learning market, with multiple course providers and relatively high course enrollments. This demonstrates a sustainability and scalability that many recent instructional approaches and products have yet to demonstrate.

Algebra I is a popular online course for many reasons. Younger, advanced students may feel ready to learn algebraic concepts before their full-time, regular school program is ready to teach them. Other students who take Algebra I and don't pass the class the first time likely feel compelled to try again because completion of Algebra I is required for high school graduation. At the same time, a shortage of qualified math teachers in secondary schools across the nation may limit the availability of algebra instruction in some areas. Online learning could play an important role in increasing U.S. students' access to quality Algebra I instruction. Current research suggests that algebra-ready eighth-grade students in rural settings benefit from access to online algebra instruction (Heppen et al., 2012). Other research findings about online learning more generally also suggest that, on average, students in online learning do just as well as their peers in traditional, face-to-face courses (Means, Toyama, Murphy, Bakia, & Jones, 2010; Sitzmann, Kraiger, Stewart, & Wisher, 2006).

In addition to the reasons to focus on online algebra courses specifically, there are also reasons to look in more depth at online courses generally. Online learning is becoming an established part of the formal education system. For example, the number of states and school districts requiring online courses for high school graduation is growing. In addition to Alabama, Florida, Michigan, and multiple districts, Virginia and Idaho added the requirement in the 2011–12 school year (Watson et al., 2012). In several states, students are required to have at least an online experience, if not an online course. Other states, such as Georgia, are recommending but not requiring them. School officials in these areas see participation and success in online courses as a necessary step toward college- and career-readiness. Online courses have also become relatively common offerings in postsecondary education. During the fall 2010 term alone, nearly one-third of all students in postsecondary education were taking at least one online course, and over 6 million students in total were taking at least one online course (Allen & Seaman, 2011).

Why Focus on At-Risk Students?

Despite evidence of the average effectiveness of online and blended learning compared to traditional face-to-face instruction (Bowen, Chingos, Lack, & Nygren, 2012; Heppen et al., 2012; Means et al., 2010), there is an emerging body of research that suggests participation and success in online learning is not equal across different student subgroups.

Our operational definition of at-risk students follows that used in the literature (e.g., Chen & Kaufman, 1997; Finn & Rock, 1997):

1. Low-income students (defined as students who qualify for free and reduced-price lunch),

2. Underprepared students (including those who have been held back a grade and those who did not perform at grade level on their last standardized achievement test),

3. English language learners, and,

4. Some ethnic minorities. [5]

Many of these subgroups appear to be underserved in online learning. At-risk students appear to less likely to enroll in online learning (Miron & Urschel, 2012). When they do enroll in online courses, at-risk students appear to be less likely to persist and more likely to get lower grades, on average, than their at-risk peers in face-to-face courses, holding course content and gender constant across groups (Bakia et al., 2011; Jaggars, 2011). While more research is needed regarding the needs and performance of at-risk students, the immediate concern is that online learning could become a tool that inadvertently widens the achievement gap. Without careful attention to its design and implementation, online learning could become just another option for students already succeeding in the traditional system (Roblyer & Davis, 2008). Therefore, special consideration and instructional adjustment may be required to support at-risk student success in online courses.

Organization of This Report

The report is in two parts: Part 1 summarizes practices across course providers and Part 2 presents individual Provider Profiles for each of the six course providers. The report also includes two appendices that describe a literature review conducted to identify research-based practices associated with student academic achievement (Appendix A) and provide more detailed information regarding the research methods supporting this study (Appendix B).

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5 We omit students with disabilities because the needs of these students are hypothesized to be somewhat unique among the broad swath of "at-risk" students and because the online learning needs of these students are being targeted by a newly funded center at the U.S. Department of Education.

Part 1: Overview of Online Algebra I Courses

Six large-scale online Algebra I course providers agreed to participate in this study.[6] As shown in Exhibit 1, the provider sample represents a range of institutional arrangements, including state-led and for-profit providers. All of the providers served secondary school students, with two providing courses that span Grades K–12. Each provider offers courses in other core subject areas in addition to Algebra I.

In addition to providing course content and supporting online tools, all of the providers participating in this study also indicated that they offer various implementation services to districts and schools to assist with operating local virtual programs. These implementation services range from hiring online teachers, providing training and professional development to marketing and communications support. Most of the providers featured in this report indicated that these types of district or school partnerships comprise a majority of their business (two even operate schools at the state level). In other schools and districts, online course providers supply the curriculum and are available to troubleshoot software, but are not involved with the implementation of online courses students. Several providers also manage their own private virtual schools where students can enroll directly, rather than through their home school, and receive all materials and support from the course provider. (See Part 2 of the report for more detailed descriptions of each provider's implementation models.)

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6 While researchers appreciated the willingness of course providers to invest time and resources to participate in this review, participation in this study should not be viewed as an endorsement or promotion of particular products.

Exhibit 1: Provider Characteristics

Provider	Type	Size and Reach	Grade Levels Targeted	Subjects Covered
Apex Learning	for profit	Enrolled over 395,000 students in 1.35 million courses in 2011–12 across all 50 states and 72 countries	• 8–12	Core Courses and World Languages
Class.com	for profit	Serves over 4,400 secondary schools across the United States	• 9–12 • postsecondary • adult	Core Courses, World Languages, Technology, and other electives
Edgenuity	for profit	Serves over 500,000 students annually in all 50 states at more than 8,000 sites	• 6–12	Core Courses and other electives
Florida Virtual School™	nonprofit	Served almost 150,000 students across Florida, the US, and internationally in 2012-13; they completed over 300,000 half-credit courses that same year	• K–12	Core Courses, World Languages, Health/Physical Education and other electives
K12	for profit	Partners with over 2,000 districts across all 50 states, and approximately 100 million enrollments worldwide.	• K–12	Core Courses, World Languages, Art, Music, Health/Physical Education, and other electives
Michigan Virtual School	nonprofit	Enrolled students in over 18,756 half-credit courses in 2011-12, across 78 of Michigan's 83 counties	• 6–12	Core Courses, World Languages and Art

Data Sources

This report is based on three data sources: research literature on promising practices in online Algebra I instruction, interviews with course developers, and an independent courseware review of six online Algebra I courses. As previously noted, our analysis did not include a review of how teachers used the courseware, nor any correspondence that occurred between students and teachers in an implementation of the course. School-based or local adaptations that may further support the use of online courses in particular settings were also beyond the scope of this study.

In interviews, we asked instructional designers, curriculum experts, and other provider representatives about their Algebra I offerings and enrollments, as well as policies and supports in place for students and teachers. They were also

asked to comment on which aspects of online learning they felt were the most challenging for at-risk students, including barriers or roadblocks to success in online Algebra I specifically and strategies they use to address these barriers.

The courseware review focused on the design and feature variability across course materials, specifically identifying course features that were present in most or all courses, were unique to one provider's offering, or were not implemented in any of the courses. The courseware review itself included a courseware review checklist that includes both a course-wide section and a lesson-level section for each of two target lessons, as well as a reading-level analysis. In the process of reviewing individual lessons across offerings, analysts logged in as students and followed through the lesson from the student perspective, reading the text, watching the videos, answering the questions, asking for feedback, and generally trying to take advantage of what is offered to aid learning. Analysts also reviewed teacher accounts for the same courses in order to understand the different monitoring, reporting, and communication tools, as well as any curricular materials available to online teachers (please see Appendix B for a description of the research methodology, including provider recruitment and courseware review).[7]

Limitations in available market and enrollment data, however, make it difficult to determine how representative these six providers are of the total range of online Algebra I course providers. The study's focus on large-scale providers suggests that these six providers account for a significant segment of the total online Algebra I enrollments.

Structure of Part 1

The remainder of this part is organized around the following key elements of an online Algebra I course:

- **Course Content**
- **Instructional Approaches**
- **Media Design**
- **Assessment, Feedback, and Reporting**
- **Implementation**

Each section starts with an overview of key concepts grounded in the research literature, followed by a description of common online Algebra I course practices identified by providers during interviews and through course reviews. Part 1 concludes with a summary of the conclusions drawn from this study.

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7 In cases where a provider offered more than one version of Algebra I (e.g., Honors, Credit Recovery), the courseware review focused on the course version that was likely to enroll the most at-risk students, either because the version was specifically geared towards at-risk students or was the version with the highest enrollments overall and would by default capture a significant number of at-risk learners. As a result, one course per provider was reviewed, for a total of six Algebra I course versions.

Online Algebra I Course Content

The online Algebra I courses reviewed for this study are often used by students to earn credit for a high school diploma. These online courses must meet the same academic requirements for learning and course content as classroom-based courses, so course scope and anticipated effort required for students are expected to be similar across options for any particular district or state. It is important to note that our review of courses did not include a systematic analysis of course scope or content coverage. We did, however, review two specific lessons in each course that addressed the same learning objective in order to make a fair comparison among the offerings. In the process of reviewing the scope and sequence of the courses, we noted considerable variation. For example, one course would address an objective in a single lesson while another might take four or five lessons and another course might not address it at all.

Understanding the Common Core State Standards for Mathematics

The Common Core State Standards for Mathematics (CCSSM) ("Mathematics Introduction, Standards for Mathematical Practice," 2012) represents an effort to provide the same, high-quality standards across states (see Exhibit 2: Common Core State Standards for Mathematics). Of the course providers included in our review, most developed their courseware before the initial release of the CCSSM in 2010 and reported that they are currently redesigning their courses according

to the new standards. As of the 2012–13 academic year, two of the six course providers profiled in this report reported that their Algebra I courses had been redesigned to align to the CCSSM. The other four reported tight alignment in current course versions, with plans to redesign and release a fully aligned version by the fall of 2014-15 school year.

The Common Core State Standards for Mathematics

The Common Core State Standards for Mathematics (CCSSM) ("Mathematics Introduction, Standards for Mathematical Practice," 2012) were designed to provide a "big ideas" framework to guide the focus of grade-level courses in mathematics. The standards, organized by grade, comprise a sequence of detailed descriptions of what students are expected to be able to understand and/or perform by the completion of that grade; that is, learning objectives. An example of such a description, called an "item," is:

> *"[Can] use the method of completing the square to transform any quadratic equation in* x *into an equation of the form* (x -- p)2 = q *that has the same solutions. [Can] derive the quadratic formula from this form."*

The standards, initially released in 2010, were developed under the direction of a consortium of U.S. states and positioned by the consortium to be adopted, eventually, as the state standards of every state.

To date, some 45 of 50 state departments of education have adopted the CCSSM, although there will inevitably be a significant time lag between when the CCSSM are adopted by a state department of education and when they have direct impact on what is actually taught in classrooms throughout the state. This is partly attributable to the need to develop new curricular materials—textbooks, assessments, and online courses—that are tightly aligned to the standards. Online assessments aligned with the CCSSM are expected to be available in the 2014–15 school year.

It is important to note that this framework of big ideas does not prescribe the content, style, sequence, or emphasis of any particular course. As a consequence, neither "Algebra I" nor "CCSS-based Algebra I" signals a fixed body of learning objectives and corresponding achievement metrics. Instead, the CCSSM encourages experimentation and offers example "pathways" in the supplemental materials available to support adoption of the standards. With these pathways the CCSSM developers detail several alternatives to what might comprise Algebra I, including a "compact" eighth-grade version, a "traditional" ninth-grade version, and an Integrated Math course informed by the approach taken in "high performing countries" (like Singapore).

Because CCSSM specifically avoids a uniform notion of what Algebra I should be, the adoption of the CCSSM won't necessarily reduce the kind of content variation we saw across courses. However, the pathways provide a useful framework for comparing which of the CCSSM items are addressed, when, and for how long.
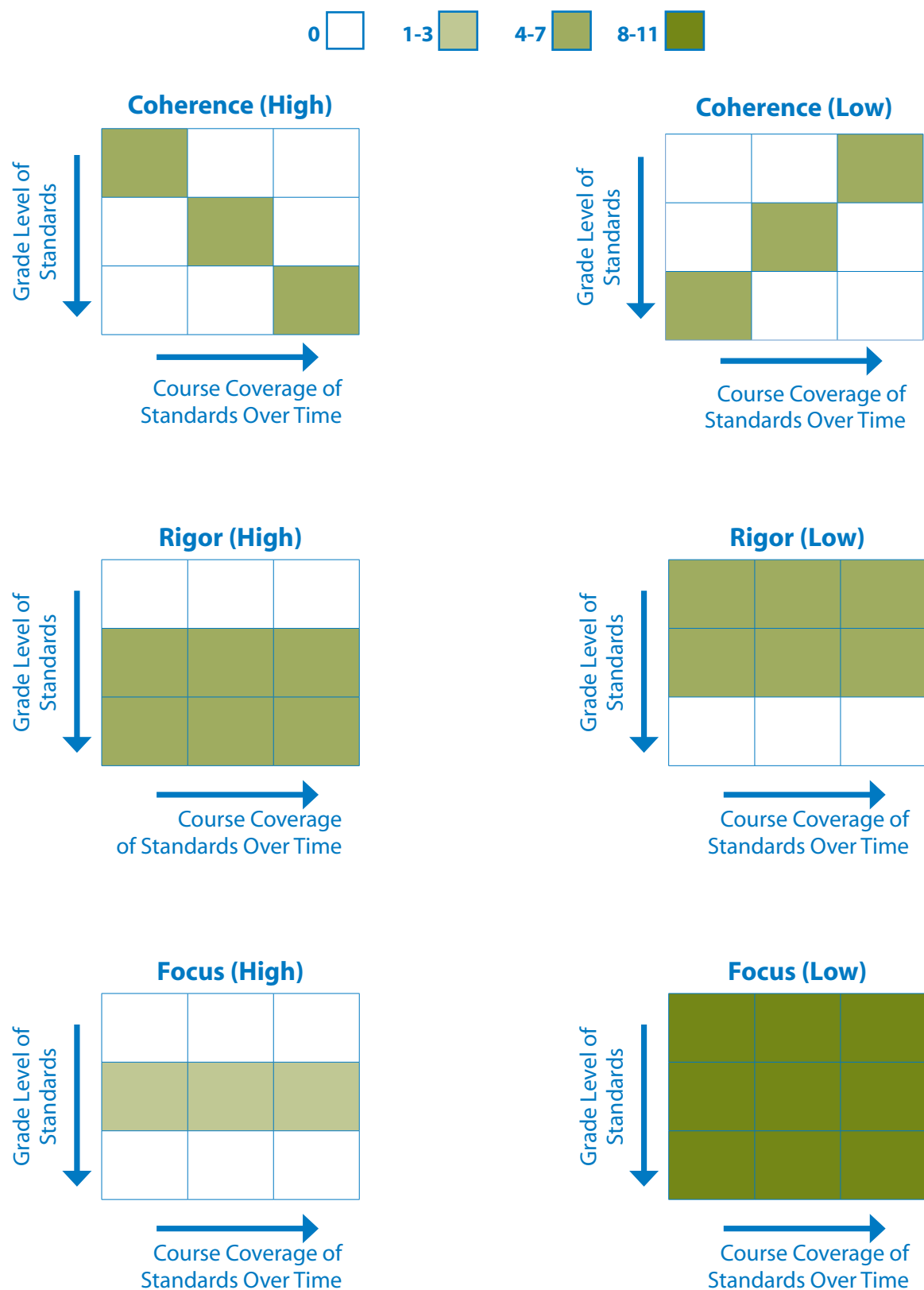
Content Rigor, Focus, and Coherence

Research suggests a link between specific variations in course content and instructional approach and student achievement. The variations that matter, however, aren't as simple as topic choice—whether or not to include quadratic equations, for example. When addressing the learning objectives, the timing of and length of time devoted to certain objectives likely matters. In particular, research points to three key characteristics of course content: rigor, focus, and coherence. **Rigor** is defined as focusing on more advanced learning objectives rather than review or more beginner learning objectives A tightly **focused** lesson sequence deals with only a small handful of related learning objectives within each lesson, and a **coherent** lesson sequence uses consecutive lessons to build students' conceptual understanding.

A recent study of face-to-face algebra courses (Brown et al., 2013) also points to the importance of balancing between review and advanced learning objectives to student success in later courses. Students in courses judged to be "rigorous" (i.e., containing more advanced objectives and fewer review objectives) were more successful in later courses than those in "beginner "courses (i.e., more review, fewer advanced). We have no reason to suspect that the situation would be different for online algebra courses. In addition, a series of international comparative studies showed that the most significant difference between an average math course in the U.S. and the average math course in any of the countries deemed to be high performing countries was that the U.S. course was much less focused and much less coherent than the high-performing country's course (Cogan & Schmidt, 1999; Schmidt, Houang, & Cogan, 2002). Such evidence points to the importance of examining these three characteristics of course content in further detail.

Exhibit 2: Rigor, Focus, and Coherence: Key Characteristics of Course Content visually illustrates the mapping of a course's standards, or learning goals, and their grade levels as they might appear across lessons. Each box, then, represents the progression of standards throughout a course's lessons. The level of shading in the boxes indicates the number of grade level standards covered by the lesson. For each of the three characteristics – rigor, focus, and coherence – the pair of boxes displays how the contrast between high and low levels of that characteristic might appear in an alignment mapping. A rigorous course, for example, would concentrate more on later grade levels than on earlier ones, so more boxes in the lower half of the map, which represent more advanced standards, would be shaded. A tightly focused lesson sequence would have a small number of related standards for each lesson; therefore the boxes would be lightly shaded. A coherent sequence would use a small number of consecutive lessons to complete any particular goal, so the slope of the progression of shaded boxes would be steeper rather than flatter. Alternatively, in the extreme case represented by our example, an entirely incoherent lesson sequence would not build on previous standards in any way.

Exhibit 2: Rigor, Focus, and Coherence: Key Characteristics of Course Content

0 □   1-3 ▨   4-7 ▨   8-11 ▨

Coherence (High)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Coherence (Low)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Rigor (High)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Rigor (Low)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Focus (High)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Focus (Low)

Grade Level of Standards →

Course Coverage of Standards Over Time →

Revealing Course Characteristics with Standards Alignment Maps

Currently, there is little empirical research to determine the optimal levels of rigor, focus and coherence for practitioners. The "right" level of each characteristic probably varies by a number of factors, including student characteristics like age and mathematical aptitude. Nevertheless, rigor, focus, and coherence together represent important dimensions for stakeholders to consider when deciding among course alternatives.

As part of our course review, we set out to develop an approach that could be used by stakeholders to estimate whether course content coverage of any particular offering – online or otherwise – embodies preferred levels of rigor, focus and coherence. We use alignment data typically made available to districts or other potential customers to create a "big picture," or overview, of a course that speaks to rigor, focus and coherence. Whether or not stakeholders create a graphic like the one described below, we recommend that potential course adopters gather information about the rigor, focus, and coherence of a course options before making a decision.

In Exhibit 3: Standards Alignment Map, we illustrate an approach to using standards alignment data to make dimensions of focus, rigor, and coherence more visible. This standards alignment map is based loosely on alignment data given to us by one of the course providers.

Rows in this diagram correspond to the grade level (as well as content areas in the case of the high school standards) of items in the CCSSM, progressing to higher and higher grades downward in the diagram. The first two columns display the standards included in the CCSS "compact" eighth-grade and "traditional" ninth-grade pathway sequences, while the rest of the columns correspond to instructional units in a hypothetical Algebra I course, progressing over time from left to right.[8] In the body of the diagram, shaded green boxes represent the number of standards for that grade level that were one of the learning goals for the unit.

The resulting "fingerprint" reveals much about a course at a glance. In this case, it is clear that a significant fraction of the course's instruction reaches far back in the grades (represented in the diagram by all of the shaded boxes above the level of the Common Core algebra sequences in the first two columns). Presumably, this characteristic represents the course designer's integrated review strategy of covering skills that are essential for algebra, but are likely to have been missed by the target audience. A trade-off of this integrated review strategy is that not as much instructional time can be devoted to more advanced topics. This fact is also evident from the map, since many of the standards envisioned by CCSSM developers for Algebra I, are not addressed by any lesson in the course (note the scarcity of boxes toward the bottom of the diagram).

In addition to an at-a-glance indication of courses' rigor, the focus and coherence are also visible in a mapping displayed in this fashion. A tightly focused and coherent lesson sequence could have as a fingerprint a narrow stripe of lightly shaded boxes running roughly from top left to bottom right. This particular fingerprint shows a lesson sequence with more coherence (fewer consecutive lessons required to communicate any particular standards item) than focus (most lessons address a fair number of standards items). This is especially noticeable in the early "review" section where, as you might expect, units have many associated learning goals and those goals are quickly covered.

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8 Many of the course providers included in the study structured their courses in terms of units, which were typically made up of roughly four to five lessons each.

Exhibit 3: Standards Alignment Map

Grade Levels	CCSS Pathway — Traditional	CCSS Pathway — Compact	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
4			4–7		1–3							
5			4–7									
6			8–11	1–3	4–7		1–3					
7			8–11	1–3			1–3					
8		✓	4–7	1–3		4–7		1–3				1–3
HS - Number and Quantity	✓	✓	1–3		1–3					1–3		
HS - Algebra	✓	✓		1–3		1–3	4–7		8–11	1–3	8–11	1–3
HS - Functions	✓	✓			1–3	1–3		4–7	1–3		1–3	1–3
HS - Modeling	✓	✓			1–3							
HS - Geometry						1–3						
HS - Statistics and Probability	✓	✓	1–3					1–3				

Grade Level Standards in the Unit — Example Course. Legend: 0 (white), 1–3, 4–7, 8–11.

Many nuances relating to the dimensions of rigor, focus, and coherence, such as the best levels for struggling math learners, remain to be worked out. In the interim, courseware visualized in this manner can provide a way for adopters and other stakeholders to determine what approach a given course is using and make reasoned judgments for themselves. Online course providers are likely to have information regarding how their course curricula line up against CCSSM, state, or other standards. Course providers need to demonstrate that they are aligned to standards in order to bear credit for high school graduation requirements. However, to use this approach, consumers have to know to ask course providers for alignment data, and they have to be knowledgeable enough to know their own target standards.

Instructional Approaches

For many years, distance education research has illustrated the importance of increasing the number and quality of interactions between teacher and student, between the student and the content to be learned, and between the student and fellow students (Bernard et al., 2009; Lou, Bernard, & Arami, 2006; Moore, 1989). Like skilled classroom teachers, effective online educators use a combination of instructional approaches to improve learning outcomes in different situations (Bransford et al., 2000; Marks, Sibley, & Arbaugh, 2005; Subban, 2006). Instructional strategies may be tailored to the specific field of knowledge and skills being taught or to the specific types of students with certain backgrounds, learning preferences, and abilities. The call out box "The Challenges of Supporting At-Risk Youth in Online Learning: The Provider-Perspective" outlines some of the most common difficulties of supporting students in the online environment, as reported by online course providers.

In the text that follows, we describe important instructional features associated with student success and describe how these principles are integrated into online courses. In the context of an online course, key instructional practices include the locus of control for guiding the student learning experience; supports for metacognition; and cues and conventions.

Locus of Control for Guiding the Student Learning Experience

Online algebra courses have the potential to include the teacher, the students, and the courseware system itself as decision-makers within the course, and researchers have demonstrated that it is possible for students to learn algebra in each of these situations (Heppen et al, 2011; Pane, Griffin, McCaffrey, & Karam, 2013; Ritter, Kulikowich, Lei, McGuire, & Morgan, 2007). In

Challenges of Supporting At-Risk Youth in Online Learning: The Provider-Perspective

In the interviews we conducted, course providers identified specific challenges associated with supporting students, particularly those who are already at-risk, including:

- **Self-motivation and self-direction.** Students' self-motivation and self-direction emerged as consistent themes across several providers. They indicated that it is harder to get students to "show up" and participate in an online environment than in a face-to-face one. For example, students may not log into the courseware or attend synchronous sessions when they are supposed to. A mismatch between student expectations for an online course and the actual course requirements may also affect student motivation. One representative suggested that students may have the impression that there is less accountability in an online course, and so they may not come prepared to invest time and energy. Another provider reported lacking time management skills among at-risk students in particular as a challenge.

- **Prior academic difficulties in face-to-face courses.** Representatives from two providers indicated that at-risk students who struggle in online courses may have been enrolled as a last resort, after having problems in face-to-face courses, such as a prior failure or disciplinary issues. Transitioning to an online environment does not inherently address any underlying problems. One provider representative noted that Algebra I is a commonly failed high school course and that many students taking online Algebra I are doing so for credit recovery or grade forgiveness.

- **Prerequisite skills.** Representatives from several providers said that students often come to their online Algebra I courses without the prerequisite math skills, and that getting through the course is challenging for those who come to it already behind. One noted that some students are not developmentally ready to think abstractly in the way Algebra I requires, and that students who have been able to slip through math classes in the past by memorizing formulas get stuck when that strategy no longer works in algebra. Another noted that there tend to be sticking points related to particular concepts, specifically quadratic equations and systems of equations. Since these concepts may come into play throughout a course, students who don't master them will continue to struggle.

- **Technology access and skills.** Two of the providers mentioned challenges related to technology. One indicated that students do not always have adequate access to functioning computers and the Internet. Another indicated that students may not have prior experience with technology or necessary technology skills. This representative noted that they encourage schools using the provider's courseware to use existing rubrics for gauging student-readiness for online learning (e.g., Roblyer & Wiencke, 2003) as a diagnostic tool to identify skills in need of improvement (rather than to exclude students from online learning); the representative also indicated this tool is rarely used in practice.

- **Online learning role models.** Another representative noted that many at-risk students might not have role models for successful online learning. In his opinion, because parents or guardians are probably not familiar with online learning, they may be less effective in helping students succeed online than they might be in helping them with traditional classes.

- **Reading comprehension skills.** One representative cited poor reading comprehension skills as a potential limiting factor for at-risk students in online courses.

- **External (nonacademic) circumstances.** Multiple providers raised the challenge of external circumstances as barriers for at-risk student success in online learning. Examples offered ranged from having a difficult home life to being enrolled in the class late. One representative noted that in an online environment it is hard for teachers and providers to know what the real problem is; that is, whether a student lacks important background knowledge or if there are external factors influencing his or her performance.

traditional face-to-face classrooms, teachers typically make most of the instructional decisions, such as what topics occupy student attention from minute to minute and how fast or slowly the instruction should progress. In an online course, on the other hand, students inevitably have some amount of control in deciding when to log-in to the course or which lessons or activities to work on. Online courses that incorporate a cognitive tutor or other artificial intelligence instructional engine use a decision-making algorithm, the result being that the system itself controls many aspects of the course.

Exhibit 4: provides examples of the kinds of elements that can be manipulated in an online course. We analyzed how these features are controlled in order to characterize the course as predominantly teacher-directed, student-directed or system-directed.

- The more of these elements that remain within the teacher's control, the more **teacher-directed** we say the course is.
- The more of these features that the student can control, either directly or, more commonly, as mediated through the teacher, the more strongly **student-directed** we say the course is.
- The more that the settings associated with these features are either automatically changed or determined, the more strongly **system-directed** we say the course is.

Exhibit 4: Elements That Can Be Manipulated in an Online Course

Hide or show modules within the course content
Enable or disable gating functions that would prevent a learner from progressing beyond certain points in the curriculum without first meeting some completion criterion
Add, remove, or change what resources (especially external, Web-based resources) are accessible to the learner in connection with specific activities
Set the intended learner progress rate so that the system generates automatic messages to the teacher when progress is out of range
Embed or remove class-wide or individual meetings within the flow of the course
Add, remove, or change free-form (typically project or extra credit) activities at various points in the course flow
Increase or decrease the level of detail provided, by default, in automated feedback on student work
Change the number of retakes a student is allowed for an assessment
Add, delete, or reorder items to be presented in an assessment

In **teacher-driven courses**, teachers have specific system resources that enable them to adjust the intended flow of the course, either for a particular class or for an individual student. None of the online algebra courses we reviewed mimicked the teacher-driven environment of a face-to-face classroom, for example, through daily remote-access instruction and communication. Nonetheless, all six courses included some amount of teacher control, and two included substantial teacher control. In each course, teachers had some degree of authority and autonomy to make decisions about content, sequence, and pacing either for the whole class and/or for individual students. Some providers give teachers the ability to add or delete instructional content, assignments, or assessment items; providers may also allow teachers to lock or unlock lessons or quizzes for particular students. One course included weekly, teacher-run live class sessions that the students would attend remotely.

In **student-driven courses**, students strongly influence the pace or sequence of the course, the instructional resources used, and even the content covered. Two of the six courses we reviewed allow students to navigate through the course freely, while four require students to demonstrate mastery of required concepts before progressing through units. In one course, each student outlines his or her own pacing schedule with teacher input. In another course, the provider emphasizes learner independence with the goal of helping students develop the skills they need to regulate their own learning. As such, students in this course can select from a variety of supplemental resources with the intention that they can create an instructional experience most suited to their interests and needs. In student-driven models, the primary role of a teacher is to serve as an instructional coach, working with students when they request assistance.

In **system-driven courses,** the courseware itself (as programmed by course designers) determines the instructional path that students follow. For instance, the system can provide a fixed path by for students by requiring them to progress through a course in a set sequence, enabling access to material sequentially and only when the student has completed the prerequisite material. Alternatively, the algorithm may be dynamic, adapting what is made available to the student on the basis of her performance. All of the courseware reviewed for this study used a system-driven approach to some degree, with three providers using system-control as a primary feature and three others including system-control as a secondary feature. The courses that are predominantly system-controlled typically follow a predetermined sequence and largely rely on system-scored assessments and system-generated feedback. None of the courses reviewed used a dynamic algorithm where individual learner performance influences subsequent instruction. (These courses differ in this respect from Carnegie Learning's Cognitive Tutor for Algebra, where individual student performance directly determines what instructional content the student encounters next.)

The online Algebra I courses reviewed for this study vary considerably in terms of who controls or directs the flow of instruction. Since this locus of instructional control reflects a specific choice by the courseware design team, it is important for future research to understand how this variation interplays with learner characteristics to influence the learning experience and, in turn, student success. Two areas in which the literature does offer evidence-based support include 1) pacing and sequencing and 2) course navigation.

Pacing and Sequencing

In online courses, pacing and sequencing of content is one important area where teachers, students, and/or the system can potentially play a key role in the instructional decision-making. Compared with traditional face-to-face classrooms, online learning environments offer increased potential for students to make choices about their learning pace and sequence. At one extreme, a course might enable students to jump freely from one topic to another, while at the other extreme, a course might require students to follow a predetermined order and/or pace. In the context of Web-based training, Sitzmann et al. (2006) found greater gains when trainees were afforded a high level of control over content, sequence, or pace. Researchers have also found learning benefits for allowing students to move at their own pace through a course or its components (Mayer, 2003; Mayer & Chandler, 2001). Student-centered pacing is new for many students who have previously walked into classrooms and followed teacher directions regarding pace and sequence. As a result, it is particularly important to consider ways to scaffold and support students' capacities to make good choices about pace and sequence.

Most of the providers we interviewed shared the belief that it is important to make expectations about sequence and pacing clear at the beginning of the course—and they offered tools to help set expectations, including student orientations, pacing guides, and best practices materials with tips for success. Several providers set specific expectations for students, stipulating how much time they should devote to the course each day or each week in order to progress at an appropriate pace. Not only do such pacing guides help set expectations for students, they can also help teachers determine whether students are on track or struggling. Using pacing guides and progress reports to identify at-risk students is a popular professional development topic across multiple providers. In at least one case, teachers also use motivational strategies to encourage student progress, such as creating a (physical or virtual) "Wall of Fame" showing courses or units completed by each student.

Course Navigation

One of the first things a student will experience when he enters a course is the navigation—how easy it is to find what he is looking for, get to where he wants to go, and understand where he is in relation to what came before and what he is supposed to do next. The literature indicates that maintaining a clear structure and high level of organization is very important for stand-alone online courses (Meyer & Thille, 2006). Having a clearly marked path helps students find their way through the course, shows students how discrete topics and skills fit into a bigger mathematical picture, and enables students to track their progress through that path.

To examine the navigability of the online Algebra I courses in this study, we created a list of navigation features and identified whether each feature was present or not present in each course.

Exhibit 5 shows the list of features with an explanation for each.

Exhibit 5: Courseware Navigation Features

Category	Feature	Explanation	No. of Courses w/ Feature
Getting started	Clicks from login to lesson	After submitting the log-in information, how many additional mouse clicks does it take to get to the lesson content?	N/A
	Progress memory	When a student logs in to the course, does the course remember where the student left off and take her directly to the appropriate course location?	1
Finding your way	Lesson navigation	Can students move between units/lessons from any given page within a lesson, for example with a permanent navigation bar or drop-down menu, etc.?	5
	Search feature	Does the courseware enable students to search for lessons and resources by keywords?	1
	Location indicator	Does the course show the student where he is within the current lesson/activity and in relation to other components/lessons, i.e., what he is doing now; what came before; and where to go next?	4
Overall characteristics	Overarching course structure	Do all the units, lessons, and lesson components fit within an overarching structure that is consistent throughout the entire course?	5
	Chronological Progression	Do the lessons have an inherent sequence that students move through in order (even if the courseware also allows students to move forward/backward as needed)?	4

The number of clicks it takes to get from log-in to lesson is one way to capture the ease of navigation and the accessibility of the lessons. Three providers enable users to reach lesson content very directly, with only two mouse clicks; two providers' courses take three clicks; while one takes five clicks.

Of the six courses we reviewed, only one remembers where a student left off and takes her directly to the right place in the course when she begins a new session. Students can still navigate to a different place if needed, but the course starts them out in the logical next place. For all of the other courses, students decide where to go when they log in.

The features and tools that help students find their way within the course have a substantial influence on the user experience. Four of the six courses have some kind of navigation feature that enables students to move from their current location in the course directly to another unit or lesson, without first navigating back to some central index. Two of those four provide a navigation panel that remains permanently on the left-hand side of the screen, and that offers a tree-view of all the units and lessons so that students can easily see the entire course structure and get to where they want to go.

The other two include a drop-down menu that remains at the top of the page and that serves the same function: students can move right to where they want to go. Another way that students might, theoretically, move about within a course would be to search for a topic of interest to find the lessons or resources that address that topic. Surprisingly, only one course provides a search function within the courseware for that purpose.

In keeping with best practices for any user-interface design (Nielsen & Hackos, 1993; Shneiderman, Plaisant, Cohen, & Jacobs, 2010), four providers indicate where students are within the course at any given time. For example, courses that employ a structure with multiple pages on a given topic would indicate to students the current page and the total number of pages in that set. Courses might also use tabs to identify different parts of the lesson (e.g., instruction, practice, assessment) and to show what part the student is currently working on, what came before, and what comes next.

Five of the six courses have a consistent structure for all units and lessons, and organize all lesson components within that standard structure. Four of the six courses structure each lesson to follow a specific chronology (e.g., direct instruction, practice, and then assessment). In each case, students are free to move forward or backward within the lesson (or between lessons), but students would understand—based on the clear chronology—that they are in fact moving forward or backward within the lesson. The other two courses rely on a compilation of resources that students can essentially explore in any order they want, without any inherent chronological order across resources.

Supports for Metacognition

Students struggling in algebra are rarely struggling in algebra only. This fact suggests that other factors, besides simply not understanding mathematical concepts, are involved in students' success and failure both in mathematics and in school more broadly. Research points to the role of metacognition in learning as a key factor in students' academic success (Brown, Campione, & Day, 1981; Garofalo & Lester, 1985; Hatano & Oura, 2003). Metacognition refers to the skill or process of reflecting on one's own learning, checking one's understanding, consciously planning and monitoring problem-solving strategies, and other forms of self-awareness related to learning.

Researchers have stressed the need for teachers to provide explicit strategy-instruction related to metacognition. For example, teachers should encourage their students to double-check their work, reflect on their solutions, and make sure that their answers are reasonable (e.g., Polya, 1973; Schoenfeld, 1987, 1992; Schon, 1983, 1987).

The Algebra I courseware we reviewed typically included features in support of metacognitive processes, such as lesson previews, outlines, or organizers, and encouragement for note-taking and/or journaling and reflection. In at least one case, occasional journaling was integrated into the course, but in most cases these are purely optional aids. Vocabulary support in some form is also a stock feature of these Algebra I offerings.

Cues, Conventions, and Comprehension Strategies

Any course and its materials—whether in person or online—employs conventions that define its content, structure, and procedures. For example, courses employ conventions around navigation, layout, chunking content, referencing, naming, and so forth. Perhaps because online courseware is currently in an exploratory phase of development, these conventions vary substantially across the providers whose Algebra I courses we reviewed. In contrast, math textbooks generally follow well-understood conventions that have been quite stable for more than a century.

For example, one comprehension strategy is for students to prescan material within a lesson to determine the relative importance and difficulty of various components. At the same time, the course materials themselves should provide cues to help the students make these determinations. The resulting mental map may assist the learner in allocating effort and attention effectively in the main content processing phase (see, for example, McNamara, 2007). These strategies especially benefit struggling learners who would otherwise have difficulty allocating effort and attention effectively, spending too much on the easy stuff, and not enough on the hard stuff, with predictable consequences. Regularly implementing this strategy, however, is nearly impossible with courseware in which the bulk of instruction is presented as video—as is the case in many online courses. The problem is that prescanning raw video content (or audio content, for that matter) is very difficult and time-consuming, and the cues, structures, and conventions that could facilitate prescanning have yet to be developed and adopted for online courseware. One potentially promising convention—from among many possibilities—would be to hierarchically structure the videos and provide a scan-friendly representation of that structure, such as a left-hand navigation that clearly displays and labels the content.

Another comprehension strategy is to actively forge connections between what a student is learning now, what has been learned in the past, and what is expected for learning in the future (Halladay & Neumann, 2012; Massey & Riley, 2013). Course materials, such as textbooks, frequently support this strategy by beginning each new topic or lesson by looking both backward and forward at previous content that is relevant to the new topic and future content that will build on this topic further. Students may also briefly revisit parts of the course where they previously encountered this topic and scan ahead to future lessons that also address that content. A well-organized and detailed index (i.e., like those that appear at the back of textbook and from which can be found lessons that explain a particular topic, such as substitution or standard form) and a search function (for online courseware) can support students in implementing this strategy online. Based on our review, however, neither indices nor search functionality are common components of online Algebra I courseware. Indeed, of the six providers whose courses we reviewed, none include a course index, and only one course has a search feature, making it difficult for most students to implement this important comprehension strategy.

These are just two of many beneficial comprehension strategies not incorporated into the cues, structures, and conventions of the Algebra I courseware reviewed in this study. Both struggling students and the field at large would benefit from a more rapid convergence to an industry-wide agreement on a set of cues, structures, and conventions that serve a much broader range of strategies than any one implementation does currently.

Supporting Struggling Students

The first thing to note is that the research addressing how to support struggling students specifically in online environments is limited. Researchers in the last few years have documented lower outcomes for struggling students in online courses compared to students enrolled in classroom-based courses (Jaggars, 2011), and work has been done to identify characteristics of successful online students (Roblyer et al., 2008; Roblyer & Marshall, 2002–03). However, students who have previously failed Algebra I or have other risk factors represent a significant portion of online Algebra I course enrollments (Bakia et al., 2011). Therefore, it is important to consider the needs of this population and identify strategies for supporting their success in online environments.

Given the limitations of the literature about students struggling in online courses specifically, we draw heavily on literature about strategies and interventions developed in school-based settings.

Dropout Prevention Interventions

The U.S. Department of Education's What Works Clearinghouse conducted a rigorous, systematic review of literature on dropout prevention programs to identify effective dropout prevention interventions (Dynarski et al., 2008). They concluded that a range of individual- and school-level approaches to increasing achievement and engagement were effective in reducing dropout rates. For example, the Dynarski study (2008) found that recognition and positive rewards for students who achieve behavioral goals (e.g., good attendance) can also be effective motivators for at-risk students. Reports of these kinds of practices by course providers were anecdotal. Providers indicated that online teachers often use motivational strategies to encourage students and promote success. For example, some teachers employed by one of the providers create a (physical or virtual) "Wall of Fame" progress chart representing courses or units completed by each student.

Interventions aimed at improving students' academic, behavioral, and social skills have similarly been found to be effective in promoting academic resilience (Dynarksi et al., 2008). Programs that focus on strengthening struggling students' test-taking, study, problem-solving, and decision-making skills were noted to be particularly effective. Instructors can also provide extra study time and emphasize recognition of students' accomplishments.

At a more general level, Dynarski et al. (2008) found empirical evidence to suggest that school- or class-based supports can promote achievement and persistence as well. Based on their review of empirical evidence, they recommend that instructors (as well as schools) work to identify and monitor students at risk of failure. They also advocate for personalized learning environments, which include, among other things, the establishment of small learning communities, smaller classes, and extended learning time. As described in the Implementation section below, all online Algebra I providers reported suggesting that sites identify mentors for students.

Gap Interventions

Yeager and Walton (2011) reviewed a class of so-called gap interventions that have demonstrated large, replicable effects. These noncognitive or social-psychological interventions target a handful of mechanisms at the heart of self-fulfilling prophesies about a learner's relationship to schooling. They are typically brief exercises that target students' thoughts, feelings, and beliefs about school and their own learning/education, often about topics such as students' potential to improve their intelligence or students' sense of belonging and value in school. Despite the fact that these interventions are often short, they significantly boost achievement; moreover, the boost is still detectable years after the initial intervention. For example, social-psychological interventions have been implemented in middle and high school math classes by the Charles A. Dana Center in 2008 (Charles A. Dana Center, 2009) at the University of Texas, reducing the percentage of high school students who repeat Algebra I from 24% to 9% (as cited in Yeager & Walton, 2011).

Yeager and Walton (2011) make the argument that online courses, especially online mathematics courses, may be the ideal embedding medium for social-psychological gap interventions. In an online course, key messages can be strategically timed and delivered in precise language. Second, the messages and activities can be student-adapted. Finally, the intervention activities and messages can be seamlessly integrated into (and thus camouflaged by) the course content and designed to work with the specific, controlled, context provided by the online course. However, we saw little evidence of gap interventions embedded within the courseware itself that would suggest that at-risk students taking online Algebra I receive explicit messages about their ability to succeed in order to counter cultural stereotypes. (We note, however, that our study did not include analysis of teacher-student correspondence, so we are unable to comment on the gap interventions that may or may not be taking place through that correspondence.)

Media Design

In e-learning environments, information can be represented in more than one form. Media elements can include on-screen text, spoken audio, animation, video, drawings, photos, and other graphics (Mayer, 2003). Research suggests that using multiple media elements can be effective for supporting student learning when the use of media follows several evidence-based design principles (Tallent-Runnels et al., 2006; Mayer, 2003). These principles suggest how online course designs might guide or assist student learning.

Among multimedia uses that appear to serve to increase student learning are the addition of graphics to words, placing text near graphics, and explaining graphics with audio. By representing content in multiple modalities, media can accommodate different learning styles and preferences, increase student engagement, allow for interactivity (Fahy, 2004), and reinforce concepts. Multimedia uses associated with a decrease in student learning include explaining graphics with both audio and redundant text and the use of "gratuitous" visuals, text, and sound. In such instances, learners are forced to split their visual attention, lowering their transfer performance and hindering their understanding of complex concepts (Mayer, Heiser, & Lonn, 2001).

This section reviews the use of media in online Algebra I courses, with a focus on the design of these materials for use by students with special needs.

Exhibit 6 summarizes the use of multimedia in the Algebra I courses we reviewed. All six courses include multimedia elements, such as video, audio, and interactive media to help enhance student learning and engagement. Video tutorials are commonly used (in six of the six courses reviewed in this study) to drive or augment instruction, and they either feature
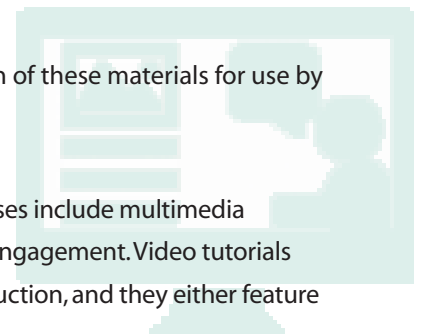
narrators or are accompanied by voice-over narration (i.e., the narrator is not visually present in the video). Two of the courses are more video-driven than the others with their instructional content organized around a series of video tutorials. Slightly less dynamic than videos, presentation slides are found in two of the courses. The key difference between videos and slides is that slides are comprised of static images and text (without audio narration).

All of the courses incorporate interactive media and attempt to engage students in interactive problem-solving, providing immediate feedback on student performance in most cases. All of the courses supplement their content with interactive games and gadgets, which may be sourced externally (e.g., located on external websites) as in the case with of one of the courses we reviewed. For example, these virtual manipulatives may allow students to solve linear equations using a balance beam representation, visualize multiplying and factoring algebraic expressions using tiles, or explore how transformations affect the graph of a function.

Exhibit 6: Common Uses of Multimedia

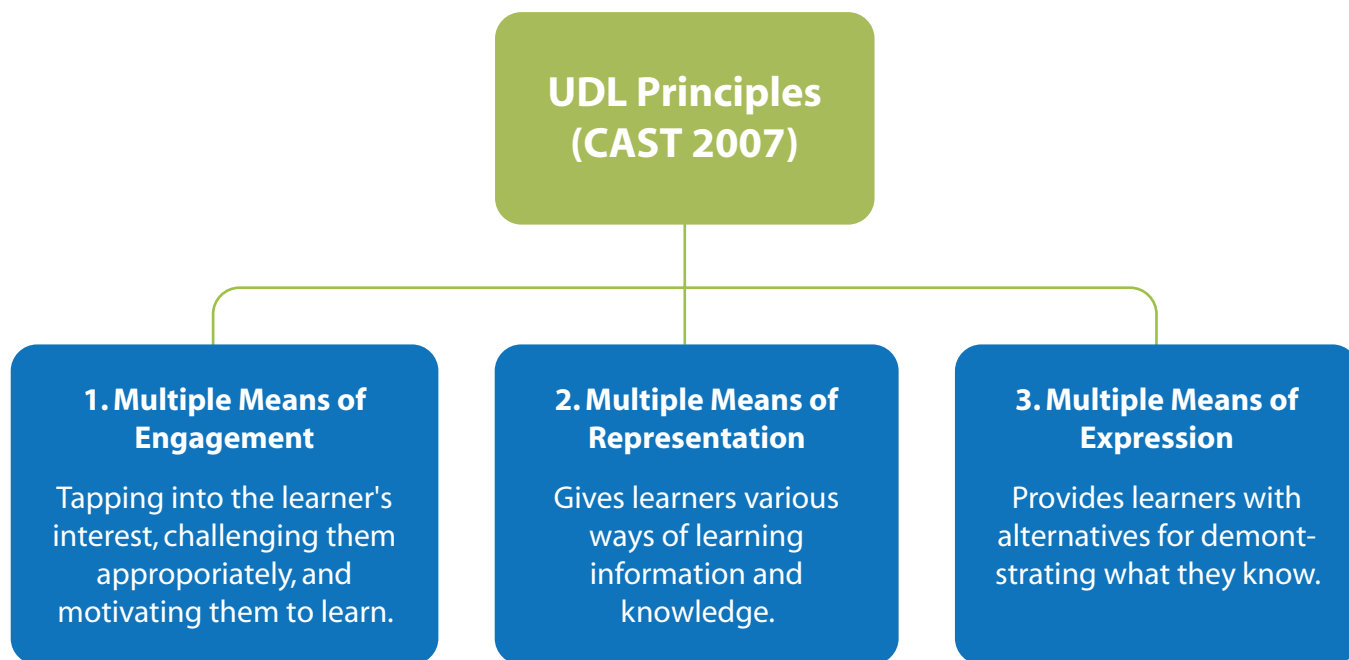| Type of Media	No. of Courses
Video (e.g., video tutorials, animated videos, video simulation)	6
Audio (e.g., voiceover in video tutorials, audio clips for vocabulary)	6
Slideshow (static images and text without audio narration)	2
Interactive Media (e.g. simulation tools, gadgets, interactive games, and puzzles)	6

Universal Design for Learning

The learning sciences research literature provides a strong consensus about the value of personalized learning environments that provide all students with learning opportunities that meet their own individual needs and preferences (Rose & Meyer, 2002). Recently, the National Educational Technology Plan emphasized the importance of personalized learning and highlighted the Universal Design for Learning (UDL) guidelines as a means for designing and building such personalized learning materials, activities, and environments (U. S. Department of Education, 2010). The UDL guidelines provide a research-based framework to support the development of learning environments that meet the needs of a diversity of learners (CAST, 2011). Specifically, the three core principles of UDL indicate that learning environments should provide learners with choices among: 1) multiple means of engagement; 2) multiple means of representation; and 3) multiple means of expression (Exhibit 7).

According to this framework, learning environments should provide students with options for engaging with content in a way that taps into individual learner interests. Learning environments should also exhibit variability and flexibility in the media and materials used to present learning content, for example, by always providing access to information through different modalities (e.g. vision, hearing, touch) or by providing information in a format that the user can adjust (e.g. text size, user-interface options). Additionally, learning environments should provide learners with flexibility in terms of what they do and generate to demonstrate their knowledge. CAST has compiled an extensive set of experimental and quantitative studies, along with scholarly reviews and expert opinions, which provide evidence-based support of the UDL principles for reducing barriers to instruction. [9]

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9 See http://www.udlcenter.org/research/researchevidence.

Exhibit 7: Applying Universal Design for Learning Principles to Online Course Content

UDL Principles (CAST 2007)

1. Multiple Means of Engagement

Tapping into the learner's interest, challenging them approporiately, and motivating them to learn.

2. Multiple Means of Representation

Gives learners various ways of learning information and knowledge.

3. Multiple Means of Expression

Provides learners with alternatives for demontstrating what they know.

1 First, every content item should be represented in multiple ways. Videos should have transcripts and closed captioning, text should have an audio equivalent, graphical items should have narrative counterparts, and vice versa. This is especially important in mathematics where connecting a variety of representations—graph to table to equation, for example—is a primary comprehension goal.

2 Analogously, learners should be provided with opportunities to show their understanding in multiple ways. This includes not only numeric responses, but also responses communicated through drawing, speaking, and enacting.

3 Finally, multiple pathways to engagement should be provided. In mathematics, especially, learning tasks and problems could be situated in a broad range of contexts: not only in term of cooking and finances, but also in design, warfare, even public transportation (Cobb & Moses, 2002).

Although not required to implement UDL, digital technologies can make customizations of curricula easier, less expensive, and more effective. Exhibit 8 summaries the results of our in-depth review of the two sample lessons within each provider's Algebra I course: Solving Linear Equations and the Quadratic Formula.

Exhibit 8: UDL Features Evidenced in Courseware

UDL Feature	No. of Courses
Multiple modes of engagement	1
Multiple modes of representation exist (text, visuals, sound)	6
Multiple modes are generally redundant	2
Multiple modes are relevant to instruction	5
Media elements have nearby explanatory text	3
Multiple modes of expression	0

All of the courses we reviewed use multiple modes of representation to present the content, including content that can be read, watched and heard, as well as content that is interactive and to which students can respond. Typically, however, the courseware does not offer these options as alternatives for the same unit of content. For example, videos rarely have a textual alternative such as a transcript and reading passages often have no spoken option.

The application of UDL was also uneven regarding expression and engagement. We saw few instances where the courseware provides multiple means of engagement, that is, providing students with options for how to engage with the content (e.g., through activities built around different themes or storylines). We also saw few instances where the courseware provides multiple means of expression. That is, there no opportunities within the reviewed lessons for students to decide how to demonstrate their knowledge (e.g., through written, illustrated, or spoken products).

Readability of Text

Readability is particularly important in online learning, where written communication is a major means of delivering instruction. It is also an important issue for at-risk students, who may be reading one or more grade-levels below their year in school. A student may not be able to access a given math concept because the reading level of the online text is too high.

For our review, we examined course readability by measuring the word count and reading level of text presented in two targeted lessons—Solving Linear Equations and the Quadratic Formula—provided in each of the six courses. To determine the reading level, we applied the Flesch-Kincaid reading level test, a popular readability formula (DuBay, 2004), to the "essential" text within each lesson. The analysis yields a grade level for each course, indicating that most individuals with that given level of educational attainment would understand the text. See Appendix B for more details about our independent readability review.
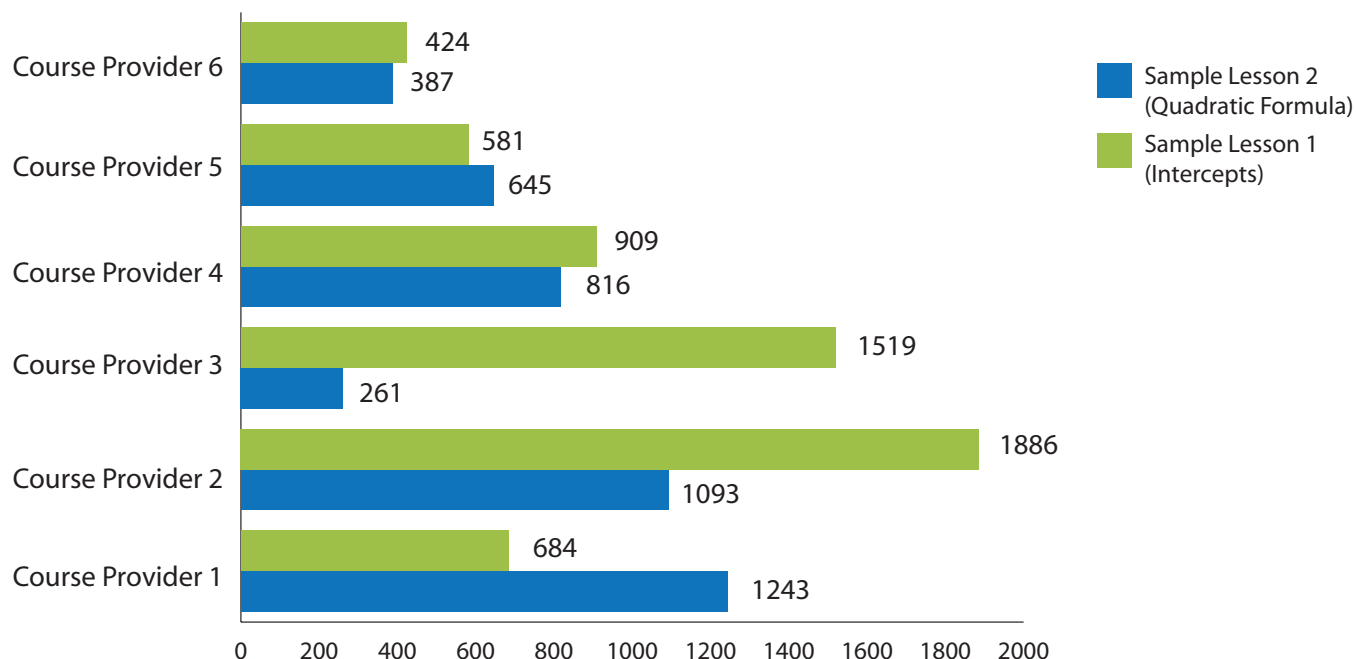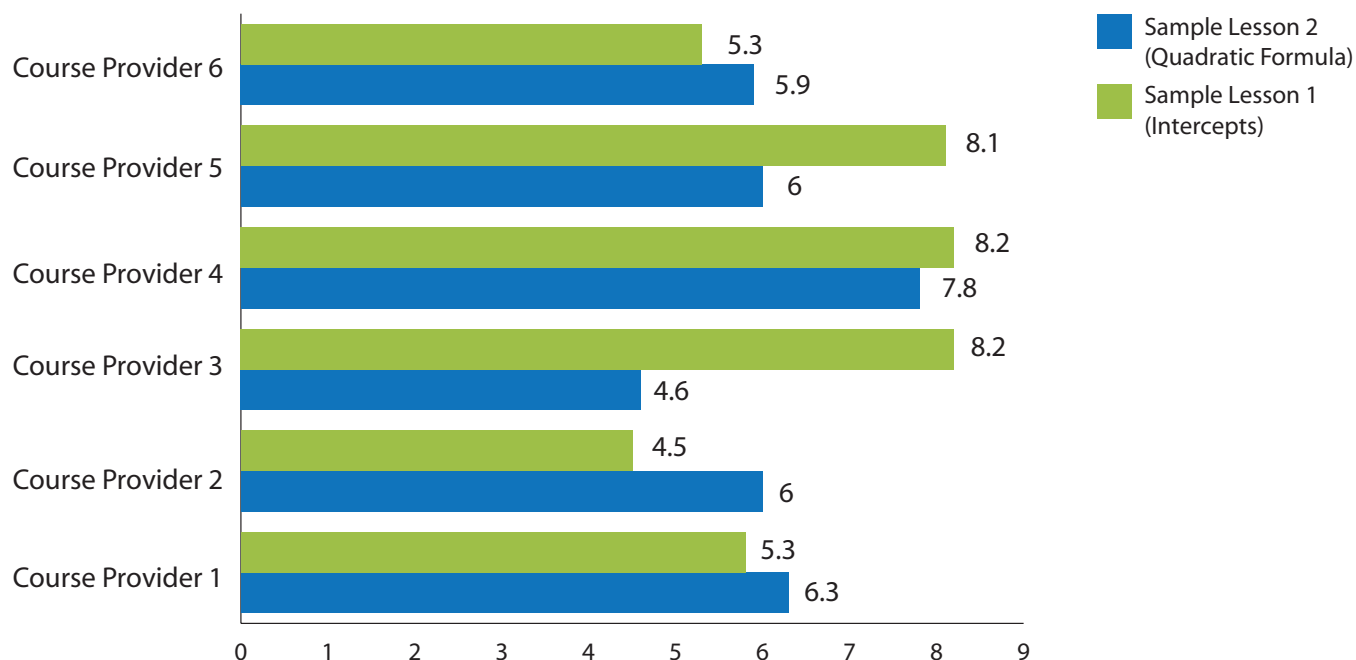
Exhibit 9: Readability—Word Count

Course Provider	Sample Lesson 1 (Intercepts)	Sample Lesson 2 (Quadratic Formula)
Course Provider 6	424	387
Course Provider 5	581	645
Course Provider 4	909	816
Course Provider 3	1519	261
Course Provider 2	1886	1093
Course Provider 1	684	1243

Exhibit 10: Readability—Flesch-Kincaid Grade Level

Course Provider	Sample Lesson 1 (Intercepts)	Sample Lesson 2 (Quadratic Formula)
Course Provider 6	5.3	5.9
Course Provider 5	8.1	6
Course Provider 4	8.2	7.8
Course Provider 3	8.2	4.6
Course Provider 2	4.5	6
Course Provider 1	5.3	6.3

We found variation among providers on the extent to which they rely on text as the primary medium of instruction. Two of the provider's courses rely heavily on video tutorials for delivery of instruction, and the use of video tutorials may present lighter demands on reading by offering alternatives to learning from text and reducing the amount of required reading. This finding is represented in Exhibit 9, with average lesson word counts across the two analyzed lessons ranging from just over 400 to over 1,400. There was also considerable variability in lesson word count within a given course (see Provider 3 in Exhibit 9 in for the most striking example).

The reading levels of the two Algebra lessons reviewed ranged from 4.5 to 8.2, with those in the lower grade range falling around the fifth-grade level and those in the higher grade range falling around the seventh- or eighth-grade level (Exhibit 10). There were also variations in reading levels *within* each courseware across the lessons reviewed (.5 to 3.5 grade levels). For two of the providers, the difference between the two lessons in the same course was more than two grade levels.

All of the lessons reviewed had reading levels that were *equal* to or *below* the grade levels of the intended primary target audience for these courses, namely seventh to ninth grades.[10] The reading levels for the Algebra I courses do not diverge from those of Algebra I textbooks in print (publisher-reported), which are typically written for students ages 13 and up (seventh to eighth grades and up).

Students' limited reading competencies can pose barriers to the algebra-content learning process, and courses with lower reading levels may help reduce cognitive loads on students—especially struggling readers and at-risk students—all other factors being held constant. At the same time, it is important for algebra students to acquire both the content knowledge and the reading skills appropriate to the subject domain and their grade. Mastering the vocabulary and language specific to the discipline is a key component of domain learning, and students should be given grade-appropriate texts along with necessary resources and guidance to develop reading competencies appropriate to the domain and their grade level.

Although the word count and reading level of the essential text within the course materials may vary, there are other strategies for making the text more accessible. The UDL guidelines indicate that key vocabulary, labels, icons, and symbols should be linked to or associated with alternate representations of their meaning (CAST, 2011). Examples of embedded vocabulary supports include rollover definitions, graphic equivalents, and translations. Providing text-alternatives, such as illustrations, animations, or virtual manipulatives that have explicit links to text, can also make information in text more comprehensible for learners (CAST, 2011). This can be especially important for struggling readers who would otherwise be unable to access the material. Providers incorporated these strategies to some extent (see the Media Design and UDL sections); however, these scaffolds and other ways to make the text more accessible were not defined as essential text in this study and are not included here.

Communication Tools

Gilbert and Moore (1998) (as cited in Roblyer & Wiencke, 2003, p. 86) find that there are both social and instructional components to interactions among classmates in distance education. To maximize peer interactions, instructors can provide for exchanges of information among students (e.g., bios, ice breakers, photos), encourage student-to-student interaction around course content through chats and discussion boards, and offer ongoing course structures designed to promote social rapport. Communication between students and teachers is perhaps even more important. Zhao, Lei, Yan, Lai, & Tan (2005), for example, observe that "instructor involvement was the most significant moderator among all the identified factors" in their analysis of distance and online learning conditions (p. 1856).

When teachers are not based in the classroom and students are receiving instruction almost entirely online, providers expect teachers to be in frequent communication with students to discuss their progress and performance. One provider recommends weekly contact between teachers and students; two other providers expect teachers to respond to student

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10 Some providers have enrollments from students outside these grade levels, such as mature students taking Algebra I for credit recovery.

communications within 24 hours. Most providers also indicated that they make special efforts to ensure that their teachers are accessible for students who are struggling with the course. For example, teachers with one provider take turns holding virtual office hours where they are on call during the evenings and over the weekends to answer student questions; another provider offers students 12-hour availability to instructors daily. The communication tools available to students and teachers are summarized in Exhibit 11.

All six of the providers we studied offer in-course tools for communication. Communication can be categorized as synchronous or asynchronous. Synchronous communication happens when participants can share ideas at the same time, as is the case during telephone conversations, for example. Asynchronous communications like email or instant messaging do not require participants to be available at the same time. Communication tools can also be classified according to who is communicating with whom—students with instructors or students with peers—and whether the communication is one-to-one or in groups.

Exhibit 11: Communication Tools

Communication Tools	No. of Courses
Teacher-Student	
Asynchronous	6
Synchronous	4
Student-Student	
Asynchronous	5
Synchronous	4

All courses supported one-to-one asynchronous communication between a student and the instructor, and all but one also included tools to support asynchronous communication between a student and at least one other student. Observed asynchronous formats in online Algebra I courses include discussion forums (five of six courses), email (four of six courses), and internal messaging systems (three of six courses).

Four of six course providers also support synchronous communication between students and instructors through webinars or interactive whiteboard sessions using tools such as Adobe Connect, Whiteboard, or Blackboard Collaborate. Teachers for at least one provider hold full-class sessions on a routine basis as part of the regular curriculum, while teachers for two other course providers schedule supplemental, individual and/or small-group sessions to supplement instructional materials on an as-needed basis. Two of six courses support synchronous communication through live chats. Two of six also build telephone-based discussions into their instructional model.

The availability of tools in a learning environment does not necessarily indicate that the tools have been actively incorporated into the curriculum and the students' learning experience. In fact, active integration of group-based/peer interaction into the curriculum appears rare among the six courses reviewed, perhaps due rolling enrollment and self-paced course content that limits the potential for student interactions. Group activities are generally less of a focus because students' ability to work independently makes the logistics of collaborative work more challenging. In these cases, if any peer-to-peer activities are included, it's typically asynchronous.

Assessment and Feedback

Assessment, feedback, and reporting all pertain to identifying what students know and can do and providing that information to teachers and students so that they can use it to improve learning. Specifically, **assessments** refer to tasks that students complete in order to determine how well they have mastered certain content. For this study, we examined both practice problems or self-assessments, and more formal assessments like lesson quizzes and end-of-unit tests. Feedback refers to the information that students receive about their performance on the task and their mastery of the content. **Feedback** can come directly from the courseware system or from the teacher. **Reporting** refers to the mechanisms for compiling and disseminating the information about student performance on particular tasks.

The literature clearly indicates that assessment, feedback, and reporting are all critical components of teaching and learning, both in physical settings and in online courses. Assessment is important principally because of the information it provides to teachers and students regarding student achievement. Dickson (2005) found that viewing readily accessible real-time data throughout the course can be informative and motivating for both students and instructors. The most effective feedback informs learners not only whether their answer is right or wrong, but also why an incorrect answer is wrong (Cyboran, 1995). Providing links back to source material can also enhance feedback for students (Janicki & Leigel, 2001). Finally, teacher feedback is also important because of the interaction that occurs between teachers and students—something that multiple studies have found to be critical for student success in online learning (Muilenberg & Berge, 2005; Zhao et al., 2005).

Our analysis of course assessments, feedback, and reporting is based on a review of the courseware itself and thus reflects features that are visible by navigating the courseware.

Assessment

Practice problems and assessments are a core component of any course, including the online Algebra I courses reviewed in this study. All six of the courses incorporated a variety of practice and assessment tasks for students, with tasks that could be categorized as both formative (i.e., for the purpose of identifying areas of strength and weakness in order to proceed in the most appropriate way with subsequent instruction) and summative (i.e., for the purpose of measuring student mastery on the target topics) in nature. Formative assessments included practice problems, self-assessments, and quizzes, while summative assessments typically included end-of-unit and/or end-of-semester exams or assessments. All of the courses rely heavily on multiple-choice items on their assessments; three of the courses also use free-response items, where students have to provide the answer themselves, whether that is a number, an equation, a phrase, or even a short written response. Only two of providers include project- or performance-based assessments, which might include lab activities, essays or journal activities, or discussion activities.

Providers have different requirements regarding what exams students must pass, and with what minimum scores, in order to complete the course. For example:

- Two providers require students to pass cumulative midterm and final exams. Three other providers require students to take a cumulative final exam that factors into the final grade, along with other assignments and assessments (with the consequence that students do not have to pass the exam per se, in order to complete the course).
- Another provider uses a competency-based model in which students must pass each quiz and unit test with a score of 60% or more in order to move to the next lesson (and thus, in order to complete the course); however, it does not require students to pass a comprehensive final exam in order to pass the course.
- One of the state virtual schools operates in a state that requires students to pass an Algebra I end-of-course (EOC) exam in order to receive credit for the course and graduate from high school. This provider supports students by including instructions within the courseware for how to meet the requirement, but districts typically administer the EOC exam themselves. Other online providers do not get involved with administering or scoring state-required assessments.

For the most part, students can take their assessment any place that has an Internet connection; only rarely do providers require that assessments be proctored (e.g., summative assessments).

Feedback

Research has shown that formative assessment and feedback can support student learning (Black & Wiliam, 1998). In theory, one of the benefits of technology-based online courses is that they have the capability to provide automatic and immediate feedback for students. Courseware systems can provide worked solutions to practice problems, hints about specific pieces of information that would be useful in solving a particular problem, etc. Even better, online courses theoretically have the ability to provide adaptive feedback for students, offering information that addresses the specific challenges and misconceptions that an individual student has (as indicated by their incorrect answer choices), but assessment items must be designed carefully in order to support this diagnostic capability.

The type of feedback that courses within our sample offer varies from basic to in-depth. For example, all of the reviewed courses provided computer-generated corrective feedback on any multiple-choice practice assignments or quizzes. This basic feedback tells students which problems they got right and which they got wrong, providing the correct answers for the latter. Some courses provide a bit more information, not just telling students what the correct answer should be but also showing either a solution strategy or providing an explanation of how to solve the problem. In one case, the system provides this information for all items, regardless of whether the student got the particular problem right or wrong; while in most cases the system only provides that information for the problems the student got wrong.

A few providers also include some kind of adaptive or responsive feedback for students based on their performance. For example, one provider provides links to supplemental instructional videos on topics for which the student needs additional support, based on assessment performance. Similarly, another provider provides an individualized study plan after each diagnostic assessment, directing students to course topics needing further study.

Teacher Role in Assessments and Feedback

As in traditional classrooms, teachers have a role to play in assessing students and providing feedback. Like traditional classroom teachers, online teachers are a key resource for students who are struggling or need help—and all of the courses provide some mechanism for students to contact teachers with questions (often through system-supported email). All of the providers also have requirements on how quickly teachers must respond to students (e.g., responses to student emails or questions, or scoring assessments, where applicable). Generally the required turnaround time ranges from 24 to 72 hours. (As noted earlier, our analysis did not include analysis of teacher-student correspondence, so we are unable to comment on the feedback and support that may or may not be taking place through that correspondence.)

The roles that teachers play in creating and scoring assessments vary across providers. Some providers give teachers the authority to adapt or adjust the course assessments, while others give teachers control over how many times (and when) students can retake certain assessments. For example, one of the provider's teachers can modify quizzes and exams by reordering the items and/or adding or deleting items. Teachers for at least two providers can decide whether or not students can retake certain assessments (and one provider also allows teachers to decide which problem sets students have to submit to the teacher). The other provider noted that teachers will generally check in with students before allowing them to retake an assessment, to identify the problem and assign additional practice work before retesting.

While all providers include some computer-scored assessments, four of six courses also require teachers to score certain portions of assessments (see Exhibit 12). In general, the computer-scored assessments (or portions of assessments) are multiple-choice and focus on recall, comprehension, or application of knowledge and skills. In contrast, teacher-graded assessments (or portions of assessments) usually have a more open-ended format (e.g., written response) and typically focus on higher-order understanding, such as analysis and argumentation. Two courses have summative assessments (i.e., unit and semester tests) that include both computer-graded and teacher-scored components. A third course requires teachers to grade one to two open-ended items at the end of each assessment and conduct monthly discussion-based assessments by phone with students. These monthly check-in assessments are focused on content, and teachers and

students have the opportunity to discuss topics (or potentially even individual practice items) from the lesson(s) that were challenging for students. A fourth provider has a specific type of assessment designed to target higher-order thinking, which requires written student responses and is graded by a teacher.

Exhibit 12: Assessment Grading

| Assessment Grading	Example	No. of Courses
Teachers Grade Unique Types of Assessments	Oral presentation	3
Teachers Grade Open-Ended Portion of Unit Assessments	Written response	3
No Teacher Grading	Multiple-choice	1

Monitoring and Reporting of Student Progress, and Achievement

Learner Dashboards

In keeping with the notion that learners, especially struggling learners, strongly benefit from timely feedback (Hattie & Timperley, 2007), courseware designers typically provide access to some version of a learner dashboard so that students have support for reflecting on their progress day-to-day.

All six providers offered some form of a learner dashboard. A schematic based on the typical dashboard we observed in the courseware is illustrated in Exhibit 13. It graphically presents a student's progress revealing how much he has accomplished in the course so far, how much work remains, and the quality of the work (e.g., current grade) he has done to date. Often, but not always, the learner will be able to drill down directly from the dashboard, clicking on an item, for instance, to see more detail. In other cases, the learner may need to navigate to a separate grade book first to find out more detail.

Exhibit 13: Schematic of Typical Student Data Dashboard in Online Courses

QUANTITY of Work Done

QUANTITY of Work Remaining

QUALITY of Work Done
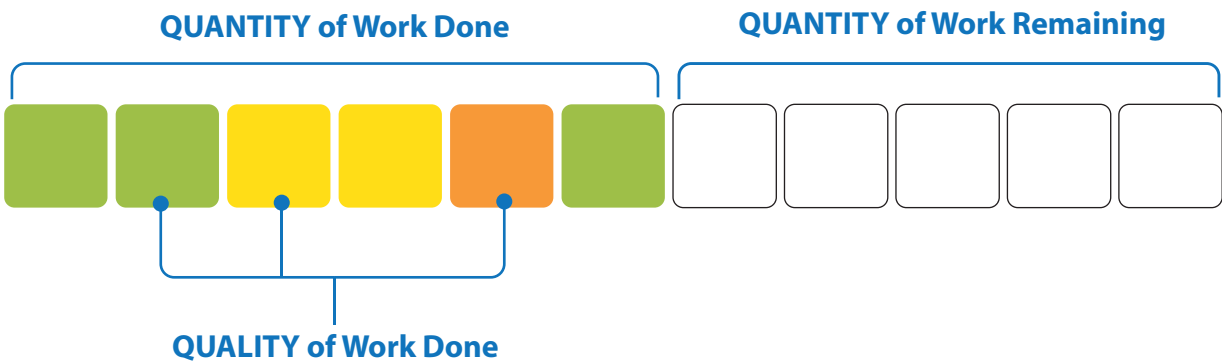
Little research has been done to gain insight into the student perspective: How do they use the data available to them? Are current displays inspiring or intimidating? While the dashboard and other features described above may serve as effective tools to promote reflection, struggling learners who may lack motivation and the requisite technology skills may not be well-positioned to use or benefit from these features without explicit training and just-in-time support.

Teacher Dashboards

All providers also expect teachers to review student data, including progress and performance indicators. Specifically, teachers can track when students are active in the course, how they are progressing with respect to an established pacing guide, and how they are performing on quizzes and exams. When students fall behind in any of these ways, teachers are expected to contact the student. Other courses have similar expectations for teachers to monitor how students are doing in the course, and to contact students (and mentors, when applicable) to resolve any problems.

All of the courseware providers participating in this study had reporting mechanisms built into their courseware, as shown in Exhibit 14. In all cases, the reports contain basic information about what activities have been completed and student scores on those activities. While some programs include all student activities in this reporting (i.e., practice sets and formative assessments as well as summative assessments), others only include some subset of those activities (usually the more summative assessments). All providers offer both teachers and students access to these reports (with different views for teachers and students). The programs usually provide some way for teachers to roll-up the data across students into some course-wide summary, or to drill-down to individual student information on particular assignments, including scores, attempts, and responses on specific items. Most providers also offer access to certain reports for parents and/or mentors.

Exhibit 14: Reporting Access

Reporting Access	No. of Courses
Teachers	6
Students	6
Parents	5
Mentors	5

Implementation

A growing segment of schools and districts are creating their own full- or part-time virtual schools, including some that offer opportunities to earn high school diplomas entirely or mostly through online courses (Watson et al., 2012). All of the providers participating in this study offer districts and schools implementation services to assist with operating local virtual programs, including hiring online teachers, and providing training and professional development as well as marketing and communications support.

When purchasing courseware, schools and districts negotiate with providers to find an implementation model that fits their needs. In doing so, they consider many factors that occur outside of the courseware, including:

- Teachers and professional development
- On-site mentor support
- Technology and technical support
- Enrollment policies and practices
- Other supports

Teachers and Professional Development

All six of the course providers offer their courses with the option to use online teachers selected and trained by the providers. In such cases, the providers report that the teachers they hire must meet federal criteria for highly qualified teachers, which include being certified in their content area and in the state in which their students are enrolled (if enrolled via their local school district). Providers note, however, that teaching online is different from classroom-based teaching. In addition to being highly qualified, online course providers also typically require the teachers they employ to receive training and ongoing professional development. In most cases, the training is not course-specific and instead focuses on topics relevant to teaching online. Exhibit 15 lists popular training topics.

Some providers intentionally recruit teachers with prior distance-learning experience, and such experience is preferred though not mandatory. One reported strategy for supporting newer teachers was to pair them with more experienced teachers or mentors who help monitor and advise their early teaching experiences.

Providers reported monitoring their teachers' performance in several ways. In some cases, teachers are monitored by a department chair or other administrative staff. These individuals commonly monitor things like teachers' actions within the system (e.g., frequency of log-in, updating course announcements) and turnaround time for student communications and grading. Course providers may also request that students complete EOC surveys or course evaluations to provide feedback on their instructor and experience in the course.

Exhibit 15: Common Training Topics

System use and features
Policies
Facilitating student-teacher interaction
Monitoring student progress
Assisting struggling individuals

On-Site Mentor Support

All six of the providers recommend that students have another adult on-site supporting them, in addition to their teacher. Popular names for these additional adult roles include mentor, coach, facilitator, and proctor. Generally, this individual is not expected to have subject-matter expertise, but unlike the teacher, is typically co-located with the student. For students taking the online course from home, the role is often filled by a caregiver or homebound coordinator, while a staff member (noncertified or certified in another subject area) may fill the role for students taking online courses in brick-and-mortar schools.

Thoughtful assignment of mentors, or adult advocates, to students has been found to be an effective way to address both social and academic at-risk student needs (DuBois, Holloway, Valentine, & Cooper, 2002; Dynarski et al., 2008; Herrera, Grossman, Kauh, & McMaken, 2011; Pettyjohn, Kennedy, & LaFrance, 2013; Tierney, Grossman, Resch, & Corporation for Public Private Ventures, 2000; Wheeler, Keller, & DuBois, 2010). The kinds of responsibilities mentors have may include to serve as a liaison between teachers and students, offer students an extra layer of support, encourage and motivate students, monitor student progress, proctor assessments, supervise and monitor behavior. Most critically, they offer on-site support. Sometimes, as is the case with two of the providers, more than one individual may support the student, each playing slightly different roles.

All of the providers offer additional guidance and resources for supporting students outside of the courseware. Each offers various resources for mentors, such as mentor-specific access to courseware, reports, and guides for supporting student understanding of course content. Other services available to students include Student Support Centers, tutoring services, and Help Desks. In some cases, these services are virtual, such as a tutoring Web application. In other cases, these services offer students place-based support. For example, struggling students enrolled with one of the providers may be required to complete their online coursework on-site at a Student Support Center.

Technology and Technical Support

Only one of the online course providers in the study reported that they sell actual technology devices such as computers to interested schools and districts. For the most part, providers require students (and their families), schools, and districts to arrange for the appropriate technologies to be available to students.

The technologies required are designed to have minimal technical requirements—typically those that would be found in a school computer lab—to support ease of implementation and lower the cost burden on purchasers. The online courses generally require a computer with a range of free standard plug-ins installed and a relatively fast Internet connection (i.e., faster than dial-up). In addition to the computer itself, speakers or headphones are typically required, and many providers recommend that students have access to a telephone, printer, and scanner or fax. While most courses have not been optimized for mobile access at this point, some course providers offer mobile applications to support their Algebra I courses. The majority of online course content is reported to be accessible on tablets and other devices.

To support implementation of the courses, all providers offer a hotline designated specifically for technical support to any student enrolled in a course (though some couple the hotline with their sales office).

Enrollment Policies and Practices

For school and district programs, a course's enrollment policies and pacing are dependent on their local calendar and preferences. Three of six providers give students the option to enroll in courses directly with them online, and all six of the providers have enrollment models in which the student enrolls in their courses indirectly through a school or district online course program. Whether or not a student has the option to enroll in a provider's courses directly is sometimes dependent on state and local regulations. In all instances, students are required to have a parent or guardian's consent before enrollment.

None of the providers stipulate official or enforced criteria for enrollment, but they do provide recommendations to schools and districts operating programs, as well as to individual enrolling students and their parents or guardians.

These recommendations typically outline providers' understanding of readiness for online learning and may include a self-assessment for online learning. The recommendations that providers offer are usually meant to help students (and their parents and teachers) identify characteristics of successful online learners and help set expectations for students new to taking online courses. For instance, one provider reported that a successful online student possesses learning skills, including time management, organization, communication, and help-seeking; they also described having a consistent schedule and access to the course as a key component of success. Another provider included self-motivation, independence, effective writing skills, and personal commitment as important factors. Districts and schools often supplement these recommendations with their own tools and policies for determining readiness, including student agreements or contracts based on the local implementation context.

Courses typically operate either on a cohort basis, in which students who enroll in the same general time frame are placed in the same class section and proceed at a similar pace through a course; or on an individualized basis, where students move through the course at their own pace, usually in mastery-based courses.

Orientation

Most online providers offer general orientation videos that familiarize students with the learning management system (LMS), provide an overview of common forms of communication, discuss policies and expectations, and give tips for preparing students to succeed in online courses. As one representative put it, it is really important to make expectations clear at the beginning of the course to set students up for success. Most providers shared this belief and offered tools designed to help set expectations, including student orientations, pacing guides, and best-practice materials with tips for success. One of the providers has introductions specific to their courses (including Algebra I). Students are often required to view the orientation before course material is unlocked, but this can usually be disabled by the local implementing authority or by the online instructor, typically when the student has previously taken a course with the provider.

Cost

Due to the many different needs of the local purchasers and the range of services that providers offer in addition to course curriculum, course-pricing models vary widely. Of the six providers interviewed, all but one offer the option of purchasing individual course licenses, where students pay a fee up front and complete a semester enrollment, the cost of which ranges from around $275 to $400 per semester. Of the for-profit course providers, all but one offered additional individual course-taking options directly to students through their private virtual schools.

Alternative licensing models may help schools and districts achieve cost savings. All but one of the providers offer concurrent licensing or enrollment options, where schools may purchase a set number of licenses that determine the maximum number of students who may use the courseware (concurrent license) or be enrolled in a course (concurrent enrollment) at one point in time. Additionally, three of six providers offer incremental purchase discounts; where the price of licenses decrease as the purchase volume increases.

Provider services beyond the standard course materials offered will increase the direct costs to schools and districts. All of the providers offer their materials with or without their online teacher support, and some offer comprehensive virtual school management services as described above.

Conclusion

The purpose of the course reviews described in this report was to provide objective information about the online Algebra I courses available on the market today. Even with our tight focus on online courses available for credit toward graduation requirements, we found considerable variation among the courses available. Providers typically offered more than one version of their Algebra I course, with student ability (from remedial to honors) the most common differentiation. Course providers also typically have a number of implementation models that allow varying degrees of local control over software use, teacher role, and administrative policies. We noted an increase in course providers opening their own accredited, virtual schools. Despite all of this activity (or maybe because of it), it is difficult to determine the market size and number of students participating represented by this subset of six providers.

In the text that remains in this section, we summarize our key findings and recommendations, using the organization of the body of the report to structure our summary.
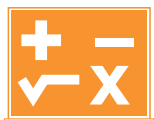
Algebra I Course Content

Many nuances relating to the dimensions of rigor, focus, and coherence, such as the best match with struggling math learners remain to be worked out. In the interim, we provided a way of visualizing rigor, focus, and coherence based on course-provider alignment data from course providers that should be available to consumers. As many states continue their efforts to adopt the Common Core State Standards for Mathematics, questions about what it means to be aligned

to the Common Core become more pressing. The trend of aligning courseware to the CCSSM is evident among the course providers profiled in this report. As of the 2012–13 academic year, two of the six course providers had aligned their Algebra I courses to the CCSSM, with the other four reporting tight alignment in current courses with plans to redesign and release a "fully" aligned version by the fall of 2014.

Instructional Approach

The online Algebra I courses we reviewed exhibited a broader trend in online education to provide additional implementation supports to encourage student course completion, including assistance with planning and prompting reflection. Practices such as student orientations, progress charts, and regular check-ins between teachers and students are becoming standard course features for supporting students' success. More often than not, these supports are available to all students rather than tailored to at-risk students specifically. However, these types of supports are likely to be especially important for at-risk students who often lack self-regulation (such as time management, discipline, and perseverance in academic settings). Providers are also creating mechanisms for teachers to identify students falling behind recommended pacing (a commonsense indicator of students developing a risk of failure in the course) in order to identify and monitor students at risk of failure. We didn't see evidence that providers were embedding gap interventions within the courseware, which have demonstrated large, replicable effects in place-based classrooms. These can likely be incorporated into course materials at a relatively low cost and offer an opportunity for providers to further improve the support provided to at-risk students.

Media Design

Our courseware review revealed that courses have adopted some of the fundamental principles of universal design, but that overall, they have a long way to go to fully address the issues of personalized learning and build courses that reflect the principles of UDL. For example, a standard feature of online Algebra I courses is to present multiple representations of lesson content—that is, parts to read, parts to watch and listen, and parts to interact with and respond to. Some courses used the affordances of hypertext such as quick links and "mouse-overs" to engage students and provide additional information based on student interest and need. However, very few courses provided students with multiple options for engaging with the content (for example, by presenting math content within the different topical contexts pertaining to student interests). None of the courses we reviewed truly gave students multiple options for expressing their knowledge (for example, by allowing students to upload products in the design and format of their choice, such as a sketched diagram, an audio explanation, etc.) It is clear that faithfully implementing these UDL principles is most practical in an online environment in which all these alternatives are available but not necessarily on-screen at the same time (as opposed to in a traditional classroom, where one teacher must work with a whole class of students). However, the algebra offerings we have examined have just begun to scratch the surface of the possibilities of the online medium for supporting universal design in order to enhance learning for all students.

Assessment and Feedback

All courses reviewed included informal and formal assessments, as well as formative and summative. We expected that there would be significant variation in the amounts and types of timely feedback on student reasoning, in addition to feedback on specific student answers, as this is likely to be key in addressing the Common Core practice, as well as content, standards. Instead, timely feedback on a student's reasoning or solution process was, uniformly across offerings, not available. Data collected by courseware still primarily focused on what answer the student provided, not the process of how they got there (the calculations involved in formulating an answer, for example). We expect this to change as courses are revised on the basis of the CCSSM recommendations.

Finally, we see opportunities to strengthen practices and further incorporate strategies around the use of data for personalization and instructional adaptability. Our sense is that data systems have limited capacity to support robust learner analytics, often because necessary data are not captured or stored in a usable format. Further research is needed to identify standards and practices that are common across the industry to allow for data interoperability and readability. Without strong technical and data systems, it will be difficult to build next-generation courseware that uses artificial intelligence to adapt curriculum scope and pace based on student performance in the system. There are some concerns in the educational community about facilitating data aggregation and analysis based on students' rights to confidentiality and the Family Educational and Privacy Rights Act (FERPA) regulations. However, it seems there are technical procedures in use today that could sufficiently anonymize data to allow analyses that inform product improvement. The data would also be useful for informing educational community about effective (and ineffective) practices.

Summary of Recommendations

The key findings from the study suggest features that consumers can look for, and that course developers can build into, the next generation of Algebra I courseware and implementation models to further support student success. Below we provide a summary of recommendations for two key stakeholders: developers and adopters of online courses.

Developers of Online Courses:

• Provide appropriate tools, such as alignment mappings, to enable local adopters to get a better sense of whether a course's rigor, focus, and coherence are the right fit for their student population. Courseware providers should provide potential users with the right tools to examine the degree of alignment to standards, even at the topic level. As more schools and districts adopt the CCSSM, this process can be streamlined.

• Incorporate UDL standards into courseware design to broaden access to online courses for all students. Research suggests that basic guidelines put forth by CAST (2011), including the inclusion of multiple means of engagement, representation, and expression, can be effective in improving instruction and learning in online learning environments.

• Embed targeted supports for at-risk students in courseware. Practices that encourage participation that can be easily implemented include gap interventions and scaffolding to support self-regulation. Courseware providers should additionally continue to provide guidance to adopters on place-based supports, such as mentors.

• Increase the amount and timeliness of feedback students receive. Research shows that such feedback is critical to student learning, and both online courseware and teachers can provide such information to students. A combination of formative and summative assessments, as well as systematic monitoring and reporting of student progress and achievement (e.g., through dashboards for both teachers and students) appear to make a difference in student outcomes.

• Provide information on student progress. While more research is needed on data dashboards for students and teachers, progress information is key to any learning experience. Online courseware provides unique opportunities for using and providing such information in new and engaging ways, such as through graphic representations or through implementation of early warning systems. Student progress data can also be used to automatically tailor content or its presentation to students, as with cognitive tutors.

Adopters of Online Courses:

• Consult with courseware providers about local policies and resources before contracting with them. Providers' degree of involvement in implementation will depend on the local needs. In addition to guidance on best practices, providers increasingly offer a range of services that includes staffing, professional development, and support for technology.

• Ensure that students—especially those at higher risk of course failure—receive the on-site support they need. While providers should further incorporate supports into courseware, there are inherent limitations to learning at a distance that can serve as a barrier to student success. Simple solutions such as ensuring access to appropriate technology or assignment of on-site staff in charge of monitoring students' progress can remedy some of these limitations.

Part 2:
Provider Profiles

Part 2 presents the individual Provider Profiles for each of the six providers participating in the study. These profiles cover the same topics as Part 1 but include greater detail to highlight the features and practices specific to each provider. Following a brief introduction to the course provider's operations, each Part 2 profile addresses: Algebra I Content Coverage; Instructional Strategies; Media Design; and Assessment, Feedback, and Reporting.

Within each of these sections, we offer an at-a-glance view of key characteristics for each provider and their courseware. Exhibit 16 shows the categories and associated features that represent the possible manifestations within the courseware.

We used a scale for describing each provider, represented in the Exhibit 16 legend by either a fully saturated, partially saturated, or unsaturated circle, in each of the categories described above. A fully saturated circle indicates that the feature or strategy is dominant throughout the courseware. A partially saturated circle indicates that the feature exists to some extent in the courseware, but not in a predominant manner; instead, it may be secondary or evenly balanced with other features or strategies. An unsaturated circle indicates that the feature is either not present or only minimally present within the courseware. *We note that the circles do not need to add up to a whole across the three features in any given category, since they are not mutually exclusive. However, within each key characteristic, no more than one category can be described as dominant.*[11]

Our goal for the tables of this style is to offer a simple visual that helps consumers of online courses understand the key dimensions along which courses vary and represents how features are enacted within a given course. The circles are purely descriptive in nature and are not designed to be interpreted or applied as ratings of quality.

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11 It is possible for providers to receive two dominant circles in the category of Driving Standards in cases where they have more than one version of their Algebra I course written to different sets of standards.

While researchers appreciated the willingness of course providers to invest time and resources to participate in this review, participation in this study should not be viewed as an endorsement or promotion of particular products. Instead, the goal of our illustrative review has been to empower decision-makers to (1) ask informed questions as they evaluate particular products and (2) make informed choices as they select materials and services to best meet their needs. This is particularly important as the landscape of Algebra I is changing rapidly, with specific products leaving and entering the market.

Exhibit 16: Key Characteristics for Each Provider and Their Courseware

Course Characteristic	Categories
	● Dominant ◑ Present ○ Absent/Minimally Present
Driving Standards: The set of standards the providers report using in developing their online courseware	*Traditional standards,* such as those from national educational organizations like the National Council of Teachers of Mathematics (NCTM).
	State-specific standards, standards that are unique to a given state.
	Common Core State Standards (CCSS), new standards that have been adopted by 45 states and the District of Columbia.
Instructional Approach: Roles of teachers and students in the online learning experience	*Teacher-directed:* teachers play a large role in deciding on content, sequence, pacing, resources, instructional delivery, and assessment and feedback for students.
	Student-directed: students have the autonomy to determine their own pacing, to move forward and backward within the course at their own discretion, and potentially to select from among different options for course materials, coursework, and assessments.
	System-directed: sequence, pacing, content, and the user-experience overall are largely dictated by the system itself.
Media Design: Information about the student experience with online learning	*Read:* Students spend their time in the course reading text.
	Watch: Students spend their time in the course watching instructional videos.
	Interact: Students spend their time in the course interacting with online content (e.g., working out problems in a step-by-step scaffolded environment or manipulating variables within a simulation).
Assessment: Assessment formats for the course	*Multiple-choice* assessments in which students select the correct or best possible answer(s) from a fixed list of choices.
	Free-response items in which students enter their own answers to assessment items, whether as a number, an equation, or a short written answer.
	Project- or performance-based assessments that require students to provide a more extended work product to demonstrate their understanding or mastery of the content (e.g., discussion-based assessments).
Feedback: Forms of feedback assessments for the course	Automatic *system-generated accuracy* information (i.e., categorical right/wrong feedback).
	Automatic *system-generated explanation* for students (e.g., reminders about definitions or formulas to use in solving the problem, a step-by-step solution).
	Teacher-generated feedback, typically for free-response items (or project-based assessments, where they exist), in which teachers offer written feedback for students on their work.

Exhibit 17 presents select recommendations and guiding questions[12] to consider when planning a quality online program, organized by the topics covered in the following Provider Profiles. These questions are intended to help readers focus on their needs and be alert to important factors to consider as they examine not only the Algebra I courses reviewed as a part of this study but other products in the market.

Exhibit 17: Guiding Questions for Selecting an Online Course

Algebra I: Course Content and Standards Alignment

- What are the content purchasing options? Build, buy, license, or a mix? Full curriculum, individual courses, individual units or lessons?
- Does the provider have their own learning management system (LMS) or can their content be dropped into the user's LMS or a third-party LMS?
- How closely aligned is the provider's content to the user's curriculum and standards? With district instructional strategies?
- Does the provider allow teachers to modify the content as they teach with it?
- To what extent does the course incorporate personalized pathways or differentiated instruction for groups and individuals?

Instructional Approach

- To what extent are students expected to take responsibility for their own learning? Will the students be self-directed or will the teacher play a central role?
- Does the course follow a flexibly paced, individualized model or a cohort model tied to a traditional school calendar?
- Does the program define how much teacher-student or student-student interaction should be incorporated into a course?
- Is face time with the teacher required? If so, how much?

Supports for At-Risk Students

- Which students will online Algebra I serve? What grade levels? First-time enrollees and/or credit recovery? Struggling to gifted? Full-time virtual students or part-time virtual students?
- Do other personnel play a role in supporting instruction, such as mentors, facilitators, or tutors? Are these staff provider-employed or recommended?
- What academic supports, including learning centers, are available from the provider? Are supports needed to supplement provider services?

Media Design

- In what ways or through what tools does the learner engage with the content?
- Are multiple modes of presentation and interactive exercises included to address different learning styles? Are these tools used to keep students attentive and engaged?
- How are courses designed to allow for student-student interaction? How does implementation affect that? For instance, does rolling enrollment limit the potential for student-student interaction?
- Are there expectations and tools for the role of student discussions and group work?
- Are necessary collaboration tools available within the LMS, or are supplemental tools required?

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12 Questions adapted from iNACOL's How to Start an Online Learning Program: A Practical Guide to Key Issues and Policies (iNACOL, 2010) and the report Keeping Pace with K-12 Online and Blended Learning (Watson et al., 2012).

Exhibit 17: Guiding Questions for Selecting an Online Course (Continued)

Assessment and Feedback

- How rapidly are teachers expected to respond to student questions or postings?
- What instruction and achievement data are captured by the LMS?
- How much of the learning experience is archived for students, teachers, parents, accountability, or other purposes?
- What are the user's reporting needs (e.g., required state report, information for governing board, evaluation reports)?
- Are automatic reports available that fit the user's needs, or is manual intervention required?
- Are reports in real-time?

Other Considerations

General

- What educational goals are users trying to meet? How are they prioritized?
- What are the user's unique educational challenges or existing constraints?
- Is the user implementing in a state with a state virtual school or state-led initiative that offers tools and resources to districts?

Professional Development

- Does the provider supply teachers that meet state requirements, or does the program use local teachers?
- If local teachers are needed, how will users plan for teacher recruitment and hiring?
- What does professional development (PD) look like for first-time online learning teachers?
- Is PD for online learning required or recommended?
- What supports do teachers need in their first year of online instruction?
- Is effective, ongoing PD available for experienced online teachers?

Enrollment

- If a student takes classes from both online schools and brick-and-mortar schools, which is responsible for maintaining the transcript, administering state tests, and submitting relevant reports and documentation?
- Will the user operate on a traditional school calendar, or will courses be open entry/open exit?
- What processes will govern enrollment and orientation?
- What guidance will be provided to students? Who provides the advising?

Technology

- What technical requirements must be met to operate the courseware? Internet access? Bandwidth? Access outside the school building?
- What end-user devices, including mobile devices, are needed?
- What facilities upgrades are required to support the program?
- What technical support is offered by the provider?
- How will implementation affect current usage of and access to existing facilities and equipment?
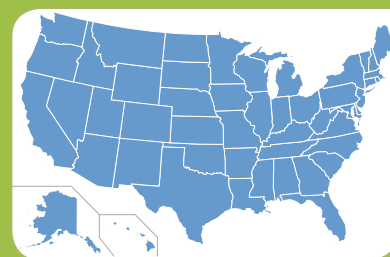
Cost

- What are the cost components? Major cost categories include management, instruction, course development/purchase, technology set-up, and technology personnel.
- What impact does program growth have on costs?

Apex Learning Inc.

www.apexlearning.com

Founded: 1997

Headquartered in Seattle, Washinton, Apex Learning, Inc. is among the largest providers of blended and online learning solutions, drawing students from all 50 states and 72 countries. In the 2011–12 school year, the company worked with 1,260 public schools and districts across the United States and enrolled 395,000 students in about 1.35 million course segments.

Courses are at the high school level in math, science, English, social studies, and world languages. Various courses or solutions are available to students seeking original credit, credit recovery, remediation, intervention, acceleration, and exam preparation. Apex Learning offers multiple course pathways to support students with a range of abilities and needs:

- **Foundations Courses:** for students who are below grade level and in need of remediation
- **General Studies Courses:**
  - **Literacy Advantage:** for students reading below proficient level
  - **Core Courses:** for students ready for grade-level academic challenge
  - **Honors Courses:** for motivated students looking to accelerate or deepen their learning
- **Advanced Placement Courses:** for highly-motivated students seeking college credit

A summary of key findings are featured in the table below.

Algebra I

Apex Learning's current Algebra I course is based on NCTM standards and state standards. A new CCSS-aligned Algebra I course is in development. Apex Learning can also tailor courses to meet individual state's standards.

Driving Standards	
Traditional (e.g., NCTM)	●
States	◐
Common Core	◐

Instructional Approach

Students receive the majority of direct instruction from Apex Learning's digital curriculum. Teachers facilitate learning, grade student work, monitor progress and performance, and intervene as needed.

Instructional Approach	
Teacher-directed	◌
Student-directed	○
System-directed	●

Media Design

Apex Learning has multimedia tutorials with images, audio, video, and animations. Students complete interactive exercises and respond to prompts as they progress through the course material.

Media Design	
Read	●
Watch	○
Interact	○

Assessment and Feedback

Course materials incorporate formative, diagnostic, and summative assessments. Computer-scored assessments are used to assess recall, comprehension, and application, while teacher-scored activities aim to assess higher-order understanding.

Assessment	
Multiple-choice	●
Free-response	◔
Project- or performance-based	○

● **Dominant**　◌ **Present**　○ **Absent/Minimally Present**

Algebra I

Each semester of the two-semester course is designed to take 18 weeks to complete, with students working on it 1–2 hours a day, 5 days a week. Districts can choose whether or not to allow students to move at their own pace by advancing to new sections when they are ready. The course can also be tailored to accommodate trimesters, block schedules, and individualized pacing. For self-paced students, Apex Learning provides its teachers with pacing and work-quality guidelines that are intended to help them distinguish students who are really learning the content from those who may be simply clicking through it.

Course Content

Curriculum experts, instructional designers, subject matter experts, assessment specialists, and teachers contribute to designing Apex Learning courses. Apex Learning's Algebra I course topics include an Introductory Algebra review; measurement; an introduction to functions; problem solving with functions; graphing; linear equations and systems of linear equations; polynomials and factoring; and data analysis and probability.

Districts have some discretion in determining which content is mandatory and may add their own content at the end of the course. They do not, however, have the option to vary the sequence of the course materials, since topics to build on each other and reference material presented earlier.

The Algebra I content (and vocabulary) of all three Algebra I courses are written at grade level or below. The Core and Honors Algebra I courses have grade-level reading, while the Algebra I Literacy Advantage course has text drawn from lower levels of Word Zone™, a list of high-frequency words in order to help struggling readers interact with grade-level Algebra I content.[13] All three courses include features to support comprehension, such as chunking of text, rollover definitions for key terms, and on-page audio. The Literacy Advantage course also includes audio assistance with instructional text.

Standards Alignment

Apex Learning uses national and major state standards to develop all of their courses to allow them to meet standards across the country. Apex Learning's Algebra I course content is based on the National Council of Teachers of Mathematics (NCTM) standards. The Common Core State Standards (CCSS) were released after Apex Learning built their current Algebra I courses. However, Apex Learning reports a high correlation between their current Algebra I courses and the CCSS; they are in the process of developing new courses for the CCSS launch in July 2013. Specifically, they plan to incorporate the instructional intent of the CCSS, including more rigorous instruction, active learning experiences, and meaningful computer-scored and performance-based assessments.

Driving Standards

Standard	
Traditional (e.g., NCTM)	●
States	○
Common Core	○

Algebra I Enrollments (2011–12)

98,000 students took Apex Learning Algebra I courses in the 2011–12 school year. *

*Apex Learning only has information on the total number of Algebra I enrollments; local education authorities maintain all other information about student enrollments.

Anatomy of an Apex Learning Lesson

The two Algebra I semesters are divided into units reflecting major topic areas; units are subdivided into lessons. Lessons begin with an overview introducing objectives and key terms, and an "Essential Question" to focus students on the big ideas. Lessons contain multiple activities:

- **Study:** direct instruction demonstrating course concepts, including multimedia demonstrations and interactive activities
- **Quiz:** computer-scored study-level or lesson-level assessment
- **Check-up:** self-assessed, free-response activity
- **Practice:** teacher-graded activity intended to apply and extend learned concepts
- **Discuss:** open-ended prompts used for online class discussions via a discussion board
- **Explore:** enrichment activities such as guided research using external web links
- **Journal:** writing activities offering opportunities to reflect on or analyze concepts and themes

Each lesson also has "real-world" problems that tie Algebra I concepts to everyday scenarios.

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13 Hiebert, E. H., & Kamil, M. L. (Eds.) (2005). *Teaching and learning vocabulary: Bringing research to practice.* Mahwah, NJ: Lawrence Erlbaum Associates.

Instructional Approach

The roles Apex Learning outlines for teachers include facilitating instruction, grading, maintaining motivational relationships with students, using reports to identify struggling students, and providing one-on-one and small-group interventions. Apex Learning expects teachers to communicate with students regularly. They may send a welcome email, announcements about assignments and exams, information about small-group instruction sessions, and notes to recognize achievements.[14] Teachers are expected to follow up with students and parents when students are not responsive to communication, have not accessed the course in more than three consecutive days, fall below 70% in their grade, or the quality of their work falters. Apex Learning encourages teachers to assist students who are struggling by providing just-in-time direct instruction to students who need help with a particular concept or skill. Teachers can use third-party synchronous software tools outside of the LMS such as Whiteboard or Elluminate to hold these sessions.

Instructional Approach	
Teacher-directed	◑
Student-directed	○
System-directed	●

Supports for At-Risk Students

Apex Learning reports that more than half of the students enrolled in their courses are "struggling." Two of Apex Learning Pathways—Foundations and Literacy Advantage—are specifically designed for students below grade level in a primary content area or in reading, respectively. For teachers, Apex Learning provides a Best Practices document that outlines strategies for helping struggling students succeed. For example, the document shows teachers how to use the learning management system (LMS) to identify unsatisfactory student progress. It also suggests motivational strategies like creating a physical or virtual "Student Wall of Fame" with stars representing courses or units completed by each student. Apex Learning also provides a course calendar to help students stay on track for successful course completion, which is automatically populated with activity due dates based on each student's start and end date. Teachers can modify the calendar for individual students or entire classes.

Apex Learning also recommends that all students have a mentor and/or a coach who meets with the student weekly. Coaches are typically a parent or guardian, but could also be a guidance counselor or homebound coordinator; mentors are staff members (not necessarily with subject area certification). Apex Learning believes regular communication between teachers, parents/coaches, and mentors creates a strong support system for students who may be struggling.

Finally, Apex reports that many districts using its materials in fully online virtual schools have a Student Support Center where struggling students can do their work on-site, receive tutoring, or have tests proctored.

Media Design

Apex Learning courses include interactive direct instruction from the digital curriculum. Apex Learning's Algebra I course includes approximately 250 multimedia tutorials including images, audio, video, and animations, as well as 250 interactive exercises per semester. Apex Learning reports that interactivity between the student and courseware gives students opportunities to check their understanding and apply what they learned and also keeps students more attentive and engaged. Apex Learning's Algebra I courseware also uses discussion boards, where teachers and student participate in asynchronous threaded discussions in response to open-ended prompts.

Media Design	
Read	●
Watch	○
Interact	○

All of the Algebra I materials are contained within the courseware; there is no textbook accompanying the digital course. Apex Learning recommends that students maintain portfolios of their work to store their notes, study sheets, graded practice sheets, and journals.

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14 Apex Learning does not have visibility into frequency of small-group, synchronous sessions.

Assessment and Feedback

Assessment

Apex Learning incorporates three types of assessments in their course materials: formative, diagnostic, and summative assessments.

Each lesson has multiple formative assessments: "Check-ups" are ungraded, free-response assessments that provide students with immediate, computer-generated corrective feedback. Computer-scored quizzes occur after direct instruction and/or at the end of the lesson; teachers can reset these quizzes to give students up to three attempts.

The diagnostic assessment for each unit is a computer-scored assessment that generates an individualized study plan directing students to course topics needing further study. Some teachers use the diagnostic assessment as a unit review, pretest, or posttest.

Summative assessments occur at the end of each unit and semester. These assessments have two parts: one scored by the computer (to assess recall, comprehension, and application) and a second scored by the teacher (to assess higher-order understanding, such as reflection, argument, and analysis).

Typically, students can complete lessons, activities, and quizzes from any computer with Internet access. Summative assessments are proctored, either in class (for students in blended environments), or by a homebound coordinator or in a Tutoring Center (for fully virtual students). Apex Learning has no central involvement with the administration of statewide end-of-course (EOC) exams for students residing in districts or states that require them.

Feedback

Apex Learning's LMS has several reporting tools that allow teachers, students, and mentors to monitor student progress and performance. Users have drag-and-drop controls in the Web-based reporting system allowing them to drill-down or manipulate data for comparative analyses.

Teachers have access to the following reports:
- **Homepage:** progress overview for all students, including grade to date, a progress indicator, overdue activities, and last access date
- **Gradebook:** summary views of student and class progress and performance, including average scores for all completed and scored activities, progress towards completion, and number of overdue activities, as well as drill-down access to see a student's score on each assessment and individual items by Bloom's level of learning[15]
- **Course Activity Scores Report:** due dates, completion dates, and scores for all scored activities
- **Student Progress Report:** overall snapshot of all students in a classroom highlighting activities overdue or not yet scored, On Schedule percent, Quality of Work percent, and days since last access
- **Student Summary Report:** individual student performance for all course enrollments, including total course session time

Students and mentors also have access to the Course Activity Scores Report with due dates, completion dates, and scores for all scored activities. Apex Learning also has an optional tool that sends parents/coaches a weekly automated email with student progress information and a link to a Detail Report with current and historical information about course access, activities due, and activities completed. Apex Learning's Best Practices for Distance Teaching recommends that teachers review student progress weekly and develop intervention plans for students who are not on track. Apex Learning advises teachers to use the formative and summative assessment data to identify individual student learning needs and provide differentiated instruction, such as tutoring and review sessions via Web conferencing.

Assessment

Multiple-choice ●

Free-response ○

Project- or performance-based ○

Feedback

System-generated accuracy ●

System-generated explanation ○

Teacher-generated ○

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15 Bloom B. S. (1956). Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc.

Other Considerations

Apex Learning primarily designs courses for students in or transitioning to high school, aged 13 and older. About 85% of Apex Learning enrollments are from students taking online courses at a brick-and-mortar school and a majority of their partnerships are at the district level. Apex Learning courses might be implemented within alternative schools, district or school-based school programs, credit-recovery programs, dropout prevention centers, summer schools, and/or with homebound students. Apex Learning also partners with a few statewide virtual schools, including those in Michigan and Iowa. Apex Learning also runs its own accredited online private school, Apex Learning High School (ALHS), where students can enroll as full-time students or for individual courses at any time.

Professional Development

Apex Learning provides customized professional development and planning for districts that purchase Apex Learning digital curriculum. For example, they may work with districts to identify promising teachers to facilitate online courses. In some cases, districts use ALHS teachers for the first year of their implementation, as they develop online instruction skills with their own teachers.

Apex Learning offers four stages of professional development—Plan, Prepare, Develop, and Evaluate—to prepare teachers for a virtual program's launch, develop their skills throughout the year, and evaluate the success of the implementation. Resources include on-site professional development, on-demand training videos, online professional development, online help, how-to videos, live support staff, webinars, and newsletters. Professional development sessions instruct participants in the International Association for K–12 Online Learning (iNACOL) National Standards for Quality Online Teaching.

Apex Learning pairs teachers with instructional coaches who serve as mentors and help teachers look at system data, provide suggestions for assisting individual students, and model strategies for teachers to use in the classroom. Teachers also participate in virtual faculty meetings to collaborate with colleagues. Subject area leaders or department heads monitor teachers' turn-around time, feedback on assignments, and application of best practices in online synchronous instruction sessions.

Enrollment

Apex Learning does not set the policies governing enrollment criteria for Algebra I. In cases where districts/schools have a limited number of licenses, the district may rank students for enrollment purposes. Districts may give enrollment priority to "high-need" students, for example, those who are close to graduation and need to fulfill a requirement, or they may use factors like prior success in online learning or grade history. In some cases, districts create and implement their own self-assessment to help students understand whether online learning is a good fit for them.

Apex Learning High School

ALHS, a private virtual school, hires teachers who have both traditional and online teaching experience. For Algebra I, the school employs 10 teachers who average nearly 20 years of total teaching experience, and 5 years teaching online. Most hold a Master's degree or higher in their subject area. Apex Learning also requires its teachers to participate in professional development. Apex Learning recommends that students successfully complete one supplemental course prior to enrolling in the full-time virtual school. Once enrolled, ALHS students have an on-site mentor whose role is to encourage, motivate, and monitor student progress.

Blended 85%

Fully Virtual 15%
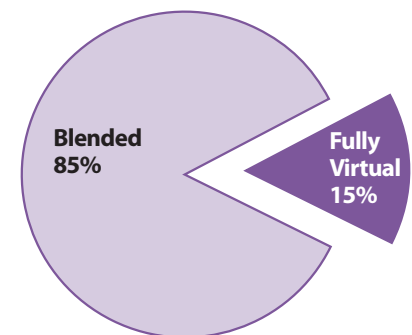
Enrollments by Implementation Model

Technology

- **Operating systems:** Windows 7, XP SP or higher, Vista; Mac OSE X Tiger, Leopard
- **Browsers:** Internet Explorer 8, Firefox 7, Safari 5, Chrome 18 or higher
- **Required plug-ins (all free):** Adobe Reader, Java, and Flash. Users also need word processing software capable of editing RTF files.
- **Connection speed:** To ensure rapid load times, courseware developers build activities with a focus on minimizing bandwidth requirements. Apex Learning advises local adopters to take into account the number of concurrent users and current bandwidth utilization. [16]
- **Additional equipment:** All users will also need speakers or headphones; some courses require print and/or scanning capabilities. Apex Learning's digital curriculum and LMS operate entirely via the Internet and thus do not require local caching servers or media servers.
- **Devices:** Apex Learning's courseware is not currently supported by mobile technologies such as smartphones or tablets, although students sometimes use their cell phones to submit an image of their work to their teacher.
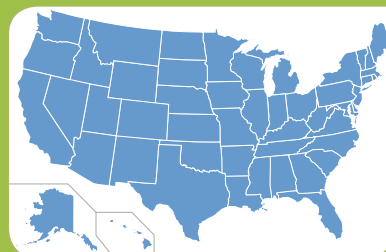
Orientation

All Apex Learning students complete an orientation before beginning their course. Districts lead these orientations, in which students watch several Guided Tour videos to help them understand how to navigate the LMS, check their progress in the course, and use the communication tools. Apex Learning also provides a "Best Practices" document for students with tips for success, such as setting aside dedicated study time and space.

Apex Learning does not supply technology to students. Some districts require students to have or have access to all the required technology in order to enroll in the Apex Learning course, while other districts provide technology to students who qualify for free- or reduced-price lunch, or even provide technology universally.

Apex Learning conducts a "system check-up" when students sign up for courses by running a diagnostic program to determine whether a student's configuration meets the technical requirements, and if not, to specify the required remedies. Apex Learning indicates that one of the most common system settings requirements is to enable pop-ups from Apex Learning domains. Apex Learning's LMS also contains a number of Online Help resources, including Getting Started Guides, Video Tutorials and Guided Tours, Frequently Asked Questions, and Best Practices.

Cost

Tuition covers enrollment in 12 semester-long courses within a calendar year, plus any required course materials. For those taking individual courses, the cost is $350 per semester course, which does not include required or optional course materials. In both cases, the price also covers support from an online teacher, access to the management system, and live progress reports. For students taking Apex Learning courses through their district, the district pays $200 per year per student, which covers 12 months of access in as many courses as the student wants to take. The annual tuition for students enrolling full-time with ALHS is $6,500 with an annual registration fee of $175.

In addition to stand-alone courses offered directly to students at the local level or through ALHS, for an additional cost the company also offers organizational assistance to help schools and districts extend the Apex Learning curriculum by implementing an online or blended learning program.

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16 http://www.apexlearning.com/systemrequirements/systemrecommendations.pdf

Class.com

www.class.com

Founded: 1999

Class.com, a commercial provider of online courseware, offers both online and blended learning solutions, in a range of subjects, for a variety of purposes including original credit, credit recovery, dropout prevention, summer school, and supplemental curriculum. They primarily partner with secondary schools nationwide to support the custom implementation of its online courses, but Class.com also operates a fully accredited [17](diploma awarding) online high school, Lincoln National Academy (LNA). LNA was established in 2010 to deliver online distance learning to students across the U.S.

Currently, Class.com serves high school students in 20 states, across 4,400 partnering secondary schools, with 4,000 students actively accessing an online course on any given day.[18] A summary of key findings are featured in the table below.

Algebra I

Class.com's Algebra I courses have been mapped to the CCSS for Mathematics and most state standards by lesson, unit, and topic.

Driving Standards	
Traditional (e.g., NCTM)	○
States	●
Common Core	◐

Instructional Approach

Class.com's online learning environment is intended to support differentiated, one-on-one instruction and allow instructors to closely monitor student work. Students taking Class.com courses via LNA are assigned to an online teacher, who is responsible for delivering instruction, grading work, monitoring student work, and providing instructional support as needed.

Instructional Approach	
Teacher-directed	◐
Student-directed	○
System-directed	●

Media Design

Class.com's Algebra I courses include interactive and multimedia elements, such as video tutorials, self-check activities and practice problems that provide immediate feedback. Built-in communication tools are intended to support interactions between teachers and students.

Media Design	
Read	●
Watch	◐
Interact	◐

Assessment and Feedback

Class.com offers formative and summative assessments. Self-checks, quizzes, and end-of-unit exams are computer-scored, and provide instant feedback at completion. Teacher-graded application assignments require written responses. Built-in customization tools are available for teachers to modify quizzes and exams.

Assessment	
Multiple-choice	●
Free-response	◐
Project- or performance-based	○

● Dominant   ◐ Present   ○ Absent/Minimally Present

17 Accredited by AdvancED/North Central Association Commission on Accreditation and School Improvement (NCA CASI).

18 Heppen, J. B., et al. (2012). *Access to Algebra I: The effects of online mathematics for grade 8 students.* Washington DC: NCES, IES, U.S. Department of Education.

Algebra I

Class.com's Algebra I offering includes two semester-long courses, Algebra IA and Algebra IB, that last about 32 to 34 weeks (or 160 to 170 days, assuming students spend 40 to 50 minutes on the course every day). Implementing schools decide whether Algebra IA will be a prerequisite for Algebra IB; occasionally, students may begin Algebra IB as they are finishing Algebra IA. For students using Class.com, the courseware supports self-pacing, allowing them to move ahead or spend extra time covering topics as needed.

At LNA, courses run on a semester-long schedule. Teachers deliver instruction synchronously on a daily basis and students login when the teacher is delivering instruction. Students who demonstrate ability to work in a self-paced learning environment have the opportunity to forgo scheduled instruction and move through the course independently, with input from their teacher. All students may complete coursework outside of scheduled instruction times.

LNA had enrolled approximately 100 Algebra I students (mostly 7th and 8th graders) in September 2012; Class.com representatives expect those numbers to double over the course of the year. LNA does not have any Algebra students who have previously failed Algebra.

Driving Standards

Traditional (e.g., NCTM)	○
States	●
Common Core	◑

Course Content

Algebra IA consists of 5 units with 13 lessons total. The first semester introduces students to symbols and number properties, functions and equations, equations and problem solving, inequalities and absolute value, and polynomials. Algebra IB has 4 core units and 2 additional units (on statistics and probability) containing a total of 18 lessons. The second semester covers functions and relations, systems of equations and inequalities, the simplification of rational and radical expressions, and quadratic equations.

Standards Alignment

Class.com's Algebra I course has been mapped to the Common Core State Standards (CCSS) for Mathematics and most state standards by lesson, unit, and topic (to view alignment, see http://class.com/resources/alignments.php). Class.com is currently editing Algebra I and all other Math and English Language Arts courses to align with the CCSS, with first semester courses scheduled for release in July 2013 and second semester courses scheduled for release in December 2013. All 7th-grade math and pre-algebra courses were newly authored after the release of the draft CCSS (but before the release of the final version of the standards).

Anatomy of a Class.com Lesson

Class.com Algebra I courses are organized into units, lessons, and topics. Each lesson is comprised of several topics that take about 50 to 55 minutes to complete. During a typical lesson, students might:

- Read static text and watch at least 1 "chalk talk," or short narrated video clip;
- Complete ten practice problems and eight "your turn," or scaffolded self-checks;
- Participate in one interactive activity; and
- Take a computer-graded multiple-choice quiz at the end.

Students also complete exams at the end of each unit and a final exam at the end of the course. The courseware also supports content customization, so teachers can change the sequence of topics or lessons, add custom content (e.g., multimedia), and set up topic-specific discussion forums.

Instructional Approach

Instructional Approach

Teacher-directed	◐
Student-directed	○
System-directed	●

Class.com's online courses are intended to facilitate differentiated, one-on-one instruction. The online learning environment allows teachers to "closely monitor student work, supplement content and test items, and implement targeted response-to-intervention strategies."[19] Key components of the courseware include interactive and multimedia elements; both computer-graded and teacher-graded assignments and assessments; and built-in communication tools.

Students taking Class.com courses through LNA enroll in a specific course section with an online teacher. Class sizes range from 12–30 students. Each teacher typically manages multiple classes at a time, supporting about 75 students across classes. Teachers provide instruction, conduct online discussions, grade written assignments, review assessment scores, communicate with students, monitor student activity in the course, and provide motivational support for students.

Supports for At-Risk Students

Class.com courseware offers a number of online help materials, including an orientation to the course environment, test-taking strategies, and navigation and study tips.

Class.com's courseware includes support for struggling readers. First, the reading level is 1-2 levels below grade-level for Algebra I (as measured by the Flesch-Kincaid Readability Scale).[20] Second, mouse-over glossary terms and audio transcripts of selected text assist students as they come across new concepts and terms.

Class.com recommends that all students have an on-site proctor (provided by the local school) in addition to their online teacher. Proctors serve as the on-site contact for students, and monitor student progress and behavior during designated class times. The messaging system (described below) enables students to correspond directly with their teachers if they need help. Teachers also provide students with pacing guides outlining deadlines for assignments and activities.

Media Design

Media Design

Read	●
Watch	◐
Interact	◐

The courseware includes interactive media elements such as:

- **Chalk Talks:** short narrated video-clips describing the solution steps for a problem; neither closed captioning nor transcripts are currently available
- **Pop-up Definitions:** definitions that appear when a user mouses over selected words
- **Your-turn Problems:** self-check problems that students complete and can then see immediate feedback indicating the correct answer and an explanation of how to solve the problem
- **Practice Problems:** additional practice problems that also provide immediate feedback with information about correctness and an explanation

Class.com courseware also provides built-in communication tools to support interactions between teachers and students. An internal messaging system and discussion boards enable teachers and students to communicate asynchronously. Teachers can post announcements on the course homepage or post supplemental materials using the messaging system. Students can email teachers using the messaging system (LNA teachers must reply within 24 hours) and post questions or comments to predefined and teacher-organized discussion boards. The courseware does not support direct peer-to-peer interaction, but could if this function were enabled.

19 http://class.com/products/full-courseware.php

20 Class.com reports using the Flesch-Kincaid Readability Scale to inform its content development process.

Assessment and Feedback

Assessment

Assessment

Multiple-choice ●

Free-response ○

Project- or performance-based ○

Each Algebra I lesson contains self-checks, practice problem sets, and a multiple-choice quiz. Each unit concludes with an online discussion (students post their response to a writing prompt), a unit assessment (multiple-choice questions) and an application assignment (short-answer questions).

For self-checks and practice problems, students receive immediate feedback on correctness of the response. For lesson quizzes and unit evaluations, students receive computer-graded scores instantly upon completion. For online discussions and application assignments, students receive a grade and written responses from the teacher (Class.com provides teachers with rubrics). Teachers can use built-in customization tools to modify quizzes and exams (e.g., reordering, dropping, or adding items). Class.com assessments are not computer adaptive, and they are not used to personalize course content.

Class.com also provides pre- and posttests (multiple-choice questions) for most of its courses. Students at LNA are required to take posttests for course completion.

Feedback

Feedback

System-generated accuracy ●

System-generated explanation ○

Teacher-generated ○

Class.com courses use the learning management system (LMS) data-logging capabilities to track online activities of students and instructional staff. The system logs: content accessed by students, grades on quizzes and exams, student course progression, and teacher data access. The system does not log students' answers to practice problems. For computer-graded assessments, grades post to the student record immediately. For teacher-graded activities/items, the purchasing school defines the teacher expectations related to turnaround of graded work.

Students have access to an online grade book where they can see quiz and exam scores; individual assessment items, their answer, and the correct answer; and feedback on teacher-graded assignments. Teachers can view a list of the items on each assessment, student responses to each item (in aggregate or by student), and student scores. Parents who have children enrolled in LNA may receive access to their student's progress if they provide a valid email address at the time of enrollment. Finally, all schools purchasing with Class.com, including LNA, manage their own set of rules as they relate to communication, course access, and more.

Other Considerations

Class.com does not require a fixed implementation model; rather, it provides course material and best practices recommendations to districts and schools deciding how to implement courses. Class.com also operates a fully accredited[21] (diploma-awarding) online high school, LNA. The online school uses Class.com's courseware in combination with trained online teachers and administrators. Students enroll in LNA independently or through their local school (where they can enroll individually or as part of a cohort) for original credit or credit recovery.

Professional Development

LNA hires, manages, and provides ongoing training for its online teachers. All LNA teachers are licensed to teach in their subject area in their resident state and must have at least a bachelor's degree with 5 years of classroom experience. Preference is given to nationally certified teachers, or teachers with a Master's degree plus 3–5 years of classroom teaching experience or online teaching experience.

Professional development for online teachers focuses on online teaching skills. Particular attention is given to online student-teacher interaction (e.g., using built-in communication tools), grading and reporting (e.g., grading subjective assessments; using grade book, reports, and teacher dashboards to monitor student performance and progress), course customization (e.g., content customization), personalization, and LMS navigation.

LNA evaluates the performance of its online teachers ongoing, based on a review of communication with students, and input from students, proctors, and local administrators. Performance feedback is provided regularly to teachers.

Enrollment

Local districts and schools manage enrollments in Class.com courses, except for LNA, which serves schools and individuals directly. Students can enroll either full- or part-time. LNA requires a minimum of 200 credits for students to earn a high school diploma, 25 of those credits (or five, semester-long courses) must be completed with LNA. Remaining credits are transferred in from a school with state or regional accreditation.

The fall semester runs from September to December, and the spring semester runs from January to June. LNA also offers summer school. The course schedule can be customized for enrollments of 12 students or more. Students must enroll 2–4 weeks prior to the course start date. The local administrator approves student enrollment with LNA to support student learning and credit transfer.

Proctors at Lincoln National Academy

All students enrolled in Class.com through LNA must have an on-site proctor. Proctors monitor student progress, administer tests and quizzes, and serve as a link between the online teacher and the school, students, and parents. Typically, the proctor is available in the classroom while the student participates in the online course.

LNA does not require proctors to have teaching credentials, although they recommend using licensed educators, such as teachers, administrators, counselors, and college faculty. If necessary, the online school can work with schools or students to identify an appropriate individual. LNA gives proctors a "proctor guide" at the beginning of the semester, and provides online training as needed.

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21 Accredited by AdvancED/North Central Association Commission on Accreditation and School Improvement (NCA CASI).

Technology[22]

- **LMS:** Class.com runs on four different industry-standard LMS, including Moodle, BlackBoard, eCollege, and ANGEL. In the future, Class.com will move toward a single platform (Moodle) to take full advantage of features supported by the LMS. All course content and materials are hosted on the Class.com server, including custom user content.

- **Operating systems:** Windows XP, Vista, 7; Mac Tiger or higher

- **Browsers:** Firefox 3.x-5.01, Internet Explorer 6.x or higher, and Safari 2.x or higher

- **Required plug-ins (all free):** Java, Shockwave, Flash, Quicktime, Adobe Reader

- **Connection speed:** At least 256kbps is recommended (minimum requirement is 56kbps). Sound card and speakers are needed.

- **Additional equipment:** Students will need a keyboard, mouse, sound card, and speakers or headphones. Additionally, Class.com requires a screen display of 1024 x 768+.

- **Devices:** Class.com courseware is compatible with mobile technologies that have Flash. Class.com plans to make all courseware available on mobile and tablet devices by the start of the 2013–14 academic year.

Class.com courses also feature a "Tech Help" module that provides step-by-step instructions for properly configuring a computer to make best use of the courseware.

Cost

Class.com offers four licensing options for schools and districts buying their online courseware:

- **Traditional enrollment,** which allows the licensed student to enroll in a single course;

- **Student license,** which grants unlimited access to a licensed student;

- **Concurrent active enrollment,** which allows a fixed number of students to enroll in a single course at the same time; and

- **Concurrent user,** which allows unlimited access for a fixed number of students.

Class.com courseware cost information may be requested directly from Class.com. The tuition for LNA is $350 per student per semester course, which includes all administrative costs.
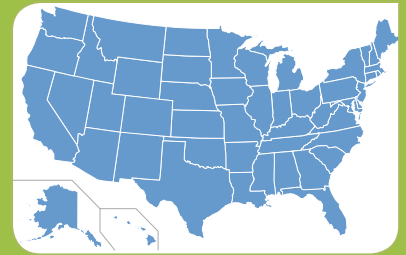
Class.com provides a toll-free phone number and a technical-support email for additional assistance at no extra cost.

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22 Full technology specifications are available at http://class.com/about/technology.php.

Edgenuity

www.edgenuity.com

Founded: 1998

Based in Scottsdale, Arizona, Edgenuity (formerly known as Education2020) operates in all 50 states and Puerto Rico at about 8,000 sites. Approximately 500,000 students enroll in one of Edgenuity's 185 core instruction, credit recovery, world languag, career and technical education and Advanced Placement courses each year. Edgenuity also offers preparation courses for standardized and state tests, which feature diagnostic testing and customized tutoring material, and career education courses.

Courses are designed for students in Grades 6–12. They feature video-based instruction from expert teachers, along with interactive tools and simulations, and online practice with immediate corrective feedback. The platform includes features to differentiate instruction for students with special needs, English language learners, and gifted students. A summary of key findings are featured in the table below.

Algebra I

Edgenuity built the course to be fully aligned to CCSS for Mathematics, and can customize it to meet specific state standards or add additional content.

Driving Standards	
Traditional (e.g., NCTM)	◔
States	●
Common Core	●

Instructional Approach

Algebra I is generally taught by district teachers. Edgenuity can also provide highly qualified state-certified instructors and coaches to provide instructional support, remediation, web meetings, office hours, grading, tutoring/concept demonstration, and monitor student attendance and progress.

Instructional Approach	
Teacher-directed	◔
Student-directed	○
System-directed	●

Media Design

Edgenuity's courseware features video-based instruction from expert teachers, as well as animations, simulations, and interactive activities intended to help engage and motivate students.

Media Design	
Read	◔
Watch	●
Interact	◔

Assessment and Feedback

Individual lessons may have practice problems, lab or journal activities, and quizzes. Students also take unit tests and midterm and final exams. Edgenuity's LMS allows teachers to monitor courseware access, progress, and achievement, and to intervene when a student is struggling.

Assessment	
Multiple-choice	●
Free-response	◔
Project- or performance-based	◔

● **Dominant**   ◔ **Present**   ○ **Absent/Minimally Present**

Algebra I

Algebra I is one of Edgenuity's most used courses with over 100,000 enrollments in 2011–12. Students can enroll as a full-year course or by semester. The full-year course takes approximately 120 hours to complete. Shorter summer and credit recovery schedules are also available. Students progress at their own pace but teachers can activate "checkpoints" that trigger teacher review and permission to proceed. In the credit recovery course, students can generally test out of content by demonstrating mastery on a pretest.

Driving Standards

Traditional (e.g., NCTM) ◐

States ●

Common Core ●

Course Content

Nearly all Algebra I content was developed in-house at Edgenuity by current and former educators. The course addresses topics covered in the CCSS, including writing, solving and graphing equations and inequalities, and linear systems. Students interact with course content via Edgenuity's Virtual Classroom Suite, an online environment with digital tools such as standard and graphing calculators, a regression tool, matrix and statistics calculators, an online notebook, and tools for highlighting and annotating text.

The reading materials for Algebra I are designed for students in Grades 7–9. Translation and read-aloud tools are available for students with language and reading challenges.

Video-based instruction from expert teachers is a key component of the course. In the videos, teachers work on a virtual whiteboard. Graphics and animations support visual learners. Students control their own pace by pausing, rewinding, and replaying instruction. Edgenuity representatives indicate that the pause button is one of the most useful tools available to students, as it enables them to take better notes as they watch and listen. Video transcripts and captions are also available. Students can search the transcripts for specific topics covered in each video. However, navigational tools such as bookmarks or searches are not available to help students find specific topics across the entire course.

Standards Alignment

Newly developed Common Core State Standards (CCSS) mathematics courses, including Algebra I, focuses on a few critical domains, or "big ideas, "to develop deep understanding of key concepts in skills within them. The CCSS courses address not only content standards but also the standards of practice related to mathematical thinking and communication. Representatives at Edgenuity indicate their course aligns to CCSS goals in these ways:

- **Focus:** Greater focus on fewer topics allows instruction to go deeper and be more comprehensive.
- **Coherence:** Connections are made between topics within the course as well as to topics from previous grades.
- **Rigor:** The course balances conceptual understanding, procedural fluency, and application.

Many districts use the CCSS-aligned Algebra I course. Edgenuity has created state-specific courses for districts in states that have added to the CCSS or created their own pathways (e.g., Arizona, California, Georgia, Massachusetts, North Carolina), and for those who have not adopted the CCSS, such as Texas and Virginia. Edgenuity can tailor the course to other states' requirements, too.

Anatomy of an Edgenuity Algebra I Lesson

Edgenuity's core lesson structure is as follows:

- **Instruction:** Students are introduced to key vocabulary and view online video lessons from experienced teachers. Brief tasks, interspersed between video sections, check for understanding.

- **Assignments:** Students engage in a number of activities, including teacher-graded journal prompts, math labs with virtual manipulatives and simulation tools, practice sets, and supplemental reading activities.

- **Assessment:** Students take a system-scored multiple-choice lesson quiz to assess mastery of the lesson content.

Instructional Approach

Students receive instruction from teachers in prerecorded video lessons and from a live teacher, either in-person or online. District teachers are expected to provide small-group instruction for their Edgenuity Algebra I students, review quizzes, assign grades, and monitor concept mastery and engagement. Edgenuity's Instructional Services team can also provide highly qualified state-certified instructors and coaches to provide instructional support, remediation, Web meetings, office hours, grading, tutoring/concept demonstration, and monitor student attendance and progress.

Instructional Approach

Teacher-directed	◓
Student-directed	○
System-directed	●

Supports for At-Risk Students

Edgenuity's courseware has several tools aimed at supporting at-risk students, for use by students and teachers. Course maps and pacing guides state expectations and provide an overview of course activities and objectives.

The notetaking tool, eNotes, aims to help students organize their thoughts as they learn new material. Students can mark up text with highlighters as they read onscreen and access specialized calculators. The glossary tool allows students to look up and record vocabulary words beyond specific terms being taught in a given lesson. The system can read text aloud in 7 different languages and can translate on-screen text into 17 different languages. Captions and video transcripts provide additional language support.

Teachers can choose whether to give diagnostic tests and whether to modify or supplement the content based on students' needs. Teachers can further individualize the course by adjusting passing thresholds, grade weights, and time limits.

Media Design

In addition to video instruction, Algebra I courseware includes animations, simulations, and interactive activities (see Anatomy of an Edgenuity Algebra I Lesson). Students take notes within the courseware in a designated eNotes area, which provides students with tools to insert math and science symbols, equations, bullets and numbered lists, and tables. Edgenuity representatives indicate the eNotes provide an advantage over paper notebooks since students can click any note to navigate back to the corresponding place in the lesson.

Media Design

Read	◓
Watch	●
Interact	◓

The Edgenuity learning management system (LMS) also enables teachers and students to communicate with one another via the announcements board (teachers only), email, threaded discussion, and chat. Teachers and students can use these tools to facilitate one-on-one direct instruction.

Teachers can also monitor students' activities, such as whether they took notes while watching a video lesson, via the teacher portal. Based on what they see, they can send messages to students to encourage note taking and other on-task behavior.

Assessment and Feedback

Assessment

Assessment

Multiple-choice ●

Free-response ○

Project- or performance-based ○

Formative assessments, quizzes, unit tests, summative assessments, and cumulative/semester exams are embedded in Edgenuity's Algebra I courseware.

Within lessons, students may complete homework or practice problems, lab activities, essays/journal activities, and multiple-choice, system-graded quizzes. Quiz results inform both teachers and students about student understanding and determine whether the course provides supplemental tutoring videos for reviewing concepts students may not have mastered.

All students must pass unit tests and midterm and final exams to complete the course. Questions are aligned to Bloom's Taxonomy, which represents levels of learning ranging from lower-order skills such as recall to higher-order skills such as synthesizing or evaluating.

Edgenuity is not involved in administering statewide end-of-course (EOC) exams for its Algebra I students in districts that require such tests. For districts using Northwest Evaluation Association Measure of Academic Progress (NWEA's MAP), Edgenuity's partnership with NWEA allows it to integrate students' MAP results into its system and recommend learning paths for students based on their scores.

Feedback

Feedback

System-generated accuracy ●

System-generated explanation ○

Teacher-generated ○

Edgenuity's LMS has tools for monitoring and reporting student progress to date. The system generates reports for students and parents, teachers, and administrators. Student reports include:

• **Progress Reports:** percent of course completed, grades, total-and-completed activity count, and scores by activity type

• **Attendance Logs:** time logged, weekly total time, count of completed-activities, and idle time

• **Scores Reports:** completed activities and number of attempts on each

• **Assignment Calendars:** autogenerated daily coursework customized to the student's timeframe, completed and assigned activities

The portal for parents and guardians allows access to Attendance Logs and Progress Reports, which can be automatically emailed. Reports for teachers, available at both the individual and class levels, focus on progress and achievement data, allowing teachers to monitor student engagement, progress, and achievement. Edgenuity provides teacher training to help teachers interpret reports, identify students needing intervention, and reteach content when needed.

Reports for school and district administrators have an Action Log, allowing administrators to monitor course and user changes made within the system for compliance with district policies, as well as enrollment reports, completed and nearly completed courses, and off-track students.

Other Considerations

Most of Edgenuity's partnerships are formed at the district level. Edgenuity courses are designed to meet a range of district needs with flexible implementation models, and content that can be used in both blended and virtual learning settings. In some districts, students receive both online and face-to-face (blended) instruction in a school setting. Virtual learning programs combine Edgenuity's courseware with an online teacher.

Professional Development

Edgenuity provides a minimum of 2 days on-site training for teachers at partner districts. The training covers transitioning to online teaching, using the system, monitoring, review of data and reporting, identifying students in need of intervention, and how to intervene. In addition to this initial training, some districts purchase as many as 25 follow-up trainings, seminars, and on-site coaching days, which are almost always done in person.

Enrollment

Districts set their own enrollment policies. Some offer online and blended courses to all students, and others limit the offering to specific populations (e.g., credit recovery, alternative education, acceleration). Edgenuity does not include an assessment related to Algebra-readiness or readiness for online learning, but districts sometimes choose to do so in order to gauge students' time management skills and self-motivation.

Orientation

Students watch a short orientation video when they first log in to the LMS for any course. The video provides an overview of the course management system, including the organization and progress tracking tools, and gives students tips for effective online learning. Teachers can choose to require the video if they wish.

Technology

- **Operating systems:** Several Microsoft and Mac versions
- **Browsers:** Internet Explorer, Firefox, Safari, Google Chrome, and others
- **Required plug-ins (all free):** Flash, Adobe Reader, Adobe Shockwave Player, QuickTime, and Java
- **Connection speed:** 256 kbps per concurrent user is recommended. Slower connections will affect performance of system multimedia elements.
- **Additional equipment:** Speakers or headphones
- **Devices:** Edgenuity courses are tablet-compatible, running on iPads, Android tablets, and Windows 8 tablets, as well as on Chromebooks. Edgenuity does not recommend running courses on smartphones, because of the small screens.

"We have an incredible range of students—from the advanced 7th grader who's ready to take high school Geometry to the high school senior who wants to take AP Psychology; to the teen mom who needs to complete two more credits to graduate with her class; to the general education student whose teacher is implementing a blended learning approach. Edgenuity's partner districts have found a lot of ways to use online learning to help students realize their educational goals."
- Edgenuity Representative

Cost

Districts typically purchase concurrent licenses that govern the number of students who can be active in a course at one time. Edgenuity prefers not to publish its pricing since the cost per license varies based on factors such as the number of licenses purchased, duration of licenses, and the number of courses. Districts generally make courses available to students at no cost.

Edgenuity also offers supports and services, such as virtual teaching or coaching support, to districts and schools.

Florida Virtual School™

www.flvs.net

Founded: 1997
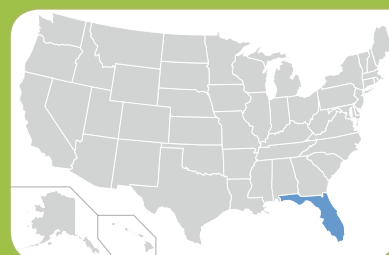
Established by state charter, Florida Virtual School (FLVS) provides online and blended learning options free of charge to all Florida students, and to students outside Florida for a fee. FLVS uses a mastery-oriented, student-directed approach, following its motto, "any time, any place, any path, any pace." In 2011–12, more than 149,000 students completed 303,329 half-credits in one of the more than 120 courses in core subjects, world languages, and electives, as well as various honors and Advanced Placement courses offered by FLVS. [23]

Most FLVS enrollments are at the high school level, but FLVS serves all Grades K–12. A typical FLVS student takes one or two FLVS courses to meet particular needs (such as credit recovery) while enrolled full-time at a physical school. A summary of key findings are featured in the table below.

Algebra I

FLVS Algebra I is a two-segment course with flexible pacing. It is aligned to the 2011 Next Generation Sunshine State Standards, with a CCSS-aligned version slated for release in Fall 2013.

Driving Standards	
Traditional (e.g., NCTM)	◐
States	●
Common Core	◐

Instructional Approach

Students are the primary drivers of course pace, with teachers providing direct instruction and student support through a combination of live online classroom sessions, as well as ongoing communication via text, phone and email, plus parent and student check-ins at least once a month.

Instructional Approach	
Teacher-directed	◯
Student-directed	●
System-directed	◯

Media Design

FLVS's Algebra I media lessons feature slideshow presentations and accompanying audio. They also incorporate interactive puzzles and access to supplemental tools.

| Media Design	
Read	●
Watch	◯
Interact	◯

Assessment and Feedback

Assessments are a mix of system- and teacher-graded. Students also have monthly scheduled discussion-based assessments with teachers by phone. Teachers, parents, and students monitor students' pace.

Assessment	
Multiple-choice	●
Free-response	◯
Project- or performance-based	◯

● Dominant   ◐ Present   ◯ Absent/Minimally Present

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[23] For 2011–12 fiscal year and final status date. A semester completion equals a successful completion (passing grade) of one semester of a course. Students who fail or withdraw from a semester of a course are not included in this number.
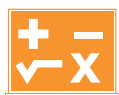
Algebra I

FVLS Algebra I consists of two half-credit course segments that students complete at their own pace. Each FLVS teacher manages approximately 165 students with rolling enrollment. FLVS offers both regular and honors enrollments in its Algebra I course, and honors enrollees complete additional assignments and tests beyond the regular course. FLVS Algebra I teachers may supplement or differentiate their materials, but the core content of each course does not vary from teacher to teacher. In FLVS' Algebra I courses, teachers work with students to tailor pacing, and students can skip through the parts of the course in which they already demonstrate mastery.

Driving Standards

Traditional (e.g., NCTM) ◯

States ⬤

Common Core ◯

Course Content

Each course is developed in-house at FLVS and revised by collaborative teams of curriculum specialists and teachers as necessary. The range and progression of topics follows Florida's Next Generation Sunshine State Standards (NGSSS), which are aligned to the CCSS in the version of the course slated for release in Fall 2013. The Algebra I course requires prior successful completion of 7th-grade mathematics. The course covers the following concepts:

• Expressions and their equivalence in the context of integers
• Functions, equations, and solving in the context of rational numbers (fractions)
• Linear equations, graphs, and lines in the plane are grounded in the rational numbers, as are inequalities and systems of linear equations
• Polynomials, including addition, multiplication, powers, and by-hand factoring, are introduced over the integers
• Square root in the context of solving general quadratic and the quadratic formula

The regular course concludes with simplification of radical expressions, while honors enrollees continue on to equations involving general radical expressions.

Before students begin Algebra I, they are offered the option of reviewing prerequisite material. The course itself consists of 10 modules or units with approximately 10–13 lessons per module. Each module begins with a pre-test intended to provide formative feedback to students and teachers. Both modules and lessons have supplemental resources corresponding to each learning objective. Algebra I also includes some 1 or 2 week "project-based" tasks.

FLVS courses are delivered through the FLVS learning management system (LMS) with the exception of Connections Academy courses, which have their own LMS.

Anatomy of an FLVS Algebra I Lesson

Each lesson begins with an introduction— either a "real-world" application or hook to build a conceptual foundation.

Then, a variety of activities or problem types may be presented to students:

• **Learn** activities are intended to activate prior knowledge, typically through low-stakes questioning.

• **Telling** activities involve direct explanation of content and completely worked examples.

• **Try It** problems are most often machine-graded, multiple-choice questions that offer students instant feedback.

• **Discover It** activities are exploratory or reasoning tasks that may involve more open-ended responses, but also culminate with machine-gradable elements.

• **Practice** sections are a sequence of problems (multiple-choice or open-ended depending on the lesson) for students to complete on their own.

• **Assess** sections consist of a compact review of the lesson and an assessment activity, which is usually either a formal online quiz or a more open-ended task (e.g., a set of problems) where a student uploads their work for teacher review. Each module also includes a discussion-based assessment that requires a direct student-teacher conversation, usually over the phone.

Standards Alignment

The current FLVS Algebra I course was designed to align with the 2011 Florida NGSSS. FLVS is developing an Algebra I course that is aligned with Common Core State Standards (CCSS) and planned for release in 2013.

Instructional Approach

In the FLVS model, teachers serve mainly as instructional coaches, monitoring student progress, teaching students in small or large groups through live lessons, providing individual instruction, providing feedback, and encouraging success. Teachers can also offer supplemental instruction, and they grade open-ended and discussion-based assessments.

FLVS is built around a partnership mastery model. Teacher authorization is required to move from one module to the next. While teachers monitor students and help them manage their chosen pacing, students' progress is the shared responsibility of the student, parent, and instructor. Additionally, Algebra I allows—but does not require—students to respond to feedback on their work by redoing it and resubmitting it to demonstrate improved mastery of the content.

The freedom afforded by a flexible time and pace places some logistical constraints on synchronous collaborative learning (related to the ability to match students who are working on similar content at any given time). However, teachers do schedule collaborative sessions if there are a number of students working on the same unit or lesson. These sessions typically use Blackboard Collaborate to connect a teacher with one or more students to provide structured question and answer sessions—referred to as "live" lessons—give a quick lecture, or work a few math problems collaboratively.

Instructional Approach

Teacher-directed	○
Student-directed	●
System-directed	○

Supports for At-Risk Students

FLVS courses primarily support students through the self-pacing and monitoring options available to all students. Beyond those options, teacher announcement pages contain resources specific to each course. Tutoring services, guided notes, and resources pages for remediation needs are also available to students. Students are encouraged to proactively communicate with their teachers, who are available to students for 12 hours a day. Teachers also make regular phone calls to students and their parents with the intention of motivating students to stay on the agreed pace.

FLVS also offers non-student online accounts to on-site facilitators, mentors, and technical helpers. Parents, in particular, are encouraged by FLVS to sign up for an account that will enable them monitor their child's progress in class.

Online tutoring is also available for a fee, through a partnership with Focus EduVation.

Media Design

FLVS Algebra I lessons incorporate slideshow presentations with audio. Text versions of the material are also available. The lessons also present interactive puzzles and links to outside resources and tools such as a scientific calculator and equation editor. FLVS recommends that students download free interactive math learning software Geogebra, which is incorporated as a supplemental tool throughout the course.

Media Design

Read	●
Watch	○
Interact	○

FLVS teachers and students can interact through the LMS by email, group and individual chat, and discussion forums. Students are also encouraged to contact their teachers by phone, and must do so to complete discussion-based assessments and to fulfill the requirement for monthly check-ins.

Assessment and Feedback

Assessment

Students in the FLVS Algebra I course take a pretest for each module. This allows students who demonstrate mastery to skip practice lessons and go on to the next module. Modules or units also incorporate two-part exams: online exams and discussion-based assessments over the phone with teachers.

The State of Florida requires an end-of-course exam for all public and charter students, including those enrolled through FLVS, in Algebra I. As of 2011–12, students must pass the Algebra I end-of-course (EOC) to receive credit for the course and graduate from high school. These computer-based EOC tests are administered by districts.

Assessment

Multiple–choice ●

Free-response ○

Project- or performance-based ○

Feedback

Through the course homepage, students can use the "Assessments" tab to view a list of their assignments. This includes a listing of submission date and the number of submissions. In the student gradebook, they can view their assignment submission dates and scores, as well as a listing of the number of points earned out of those possible. The student's pace chart is negotiated with the course instructor at the beginning of the course based on individual needs and is intended to serve as a guide for the student, teachers, and parents to track student progress.

Student progress data is available to the student, the student's teacher, and the student's parent or other monitors with appropriate system credentials. This includes which assignments have been completed with what results and remaining assignments, as well as the pace chart.

Feedback

System-generated accuracy ●

System-generated explanation ○

Teacher-generated ○

Other Considerations

FLVS also provides a range of services to Florida students, as well as to districts or schools interested in starting their own online learning programs. Within the state, FLVS courses are offered through the following models:

- **Part Time**: Individual students take courses parttime to supplement their traditional school coursework.

- **Full Time:** Individual students enroll fulltime in the Florida Virtual School District offered in partnership with Connections Academy (a division of Connections Education owned by Pearson). Florida Virtual School Full Time is a diploma-granting school of record.

- **Virtual Learning Labs:** FLVS provides curriculum and instruction to schools or districts; they in turn provide a lab, equipment, and an on-site facilitator who may or may not be a certified instructor.

- **Franchise:** FLVS provides curriculum, training, and institutional mentorship to assist schools and districts in building online learning programs using their own teachers to lead the courses.

- FLVS has full-time students in its diploma-granting Virtual Instruction Program

Orientation

Videos designed to orient students to the online course are embedded within courses as hot links. Viewing the orientation video is optional but encouraged.* Orientation topics include: course expectations, academic integrity, suggestions for preparing to study online, and practical information like how to submit assignments through the online system. Students are also pointed to additional information on Academic Integrity, Internet Safety, and Policies & Procedures.

*FLVS Quick Start New Student Orientation Videos, http://www.flvs.net/myFLVS/student-handbook/Pages/QuickStart.aspx

Outside of Florida, FLVS primarily licenses courseware, but also offers training through online professional development training and webinars. Students in other states can also enroll in FLVS Global School courses on a tuition basis.

2010–11 FLVS Enrollment by Model

	FLVS Part Time	**FLVS Full Time**	**Virtual Learning Labs**	**Franchises**
Total Semester Completions	**314,593** Grades K–5: 842 Grades 6–8: 63,013 Grades 9–12: 250,738	**24,872** Grades 6–8: 17,293 Grades 9–12: 7,579	**21,928**	**33,178**
Total Students	**149,036**	**2,468**	**12,803**	**15,246**

Professional Development

FLVS only hires teachers certified in their field and prefers to recruit teachers with prior teaching experience, but they also hire their newly licensed teachers after they complete an FLVS internship program. New FLVS teachers participate in a face-to-face orientation, systems training, and remote shadowing with experienced teachers during an induction period. New hires have an assigned mentor with scheduled calls for the first 8 weeks and as-needed assistance thereafter. All teachers must complete 30 hours of professional development a year.

Enrollment

Florida students, including homeschool and private students, work with school guidance counselors at their school of record or within their district to enroll in an FLVS course. Students outside of Florida can enroll in FLVS Global School courses through the FLVS website on a tuition basis. Parents must also approve students' enrollments in FLVS courses. Florida students who wish to take FLVS courses fulltime can enroll in the tuition-free Virtual Instruction Program (VIP) in lieu of a traditional school, with FLVS Full Time being the school of record.
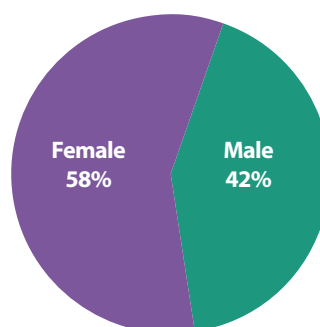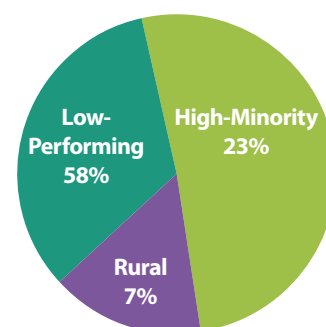
Student Semester Completions* by School Type

Public Charter 70%
Homeschool 23%
Private 7%

Student Semester Completions* by Race

Caucasian 53%
Minority 47%
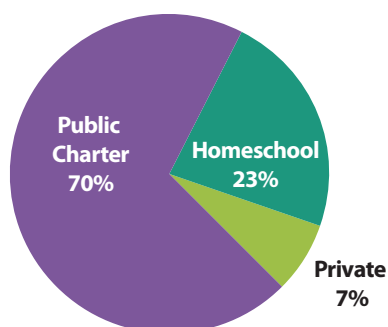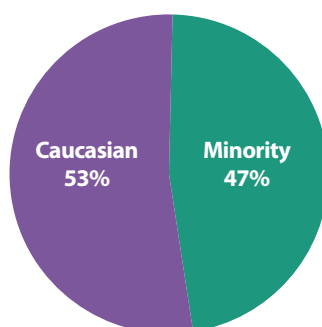
Student Semester Completions* by Gender

Female 58%
Male 42%

Semester Completions* in Priority Schools

Low-Performing 58%
High-Minority 23%
Rural 7%

*For 2011-12 fiscal year and final status date. A semester completion equals a successful completion (passing grade) of one semester of a course. Students who fail or withdraw from a semester of a course are not included in this number.

Technology

- **Browsers:** Internet Explorer 8 or 9, Firefox, Chrome, Safari
- **Required plug-ins (all free):** Java, Flash (varies by course)
- **Connection speed:** FLVS does not have Internet connection speed requirements, but tries to limit use of video in their courseware to reduce demand on bandwidth.
- **Additional equipment:** FLVS asks that students have access to a printer, speakers, microphone or headset, and a portable means to save work (e.g., USB). Videos are short and not reliant on high resolution for effect. Tools, such as graphers, sketchers, and equation editors are either Web-embedded or broadly accessible.
- **Devices:** FLVS estimates that about 70% of the Algebra I content and activities would work as-is on devices such as iPads, but does not recommend their use with the courseware.

Additionally, FLVS tries to accommodate prospective FLVS students who, on their own, are unable to secure technology resources adequate for their participation in FLVS courses. In some cases, the Foundation for Florida Virtual School provides technology grants to students based on individual need.

Cost

Florida Virtual School is a public school district funded by the state of Florida, and courses are free to students residing in Florida (as well as residents with military connections outside of Florida). The Florida legislature reimburses FLVS directly for in-state enrollments based on successful completion of a course. FLVS uses a performance-based funding model. Students not residing in Florida pay tuition per ½ credit course (1 segment) or for the complete Algebra I course (2 segments).

Services included in this cost are access to the course instructor (including by phone or email) from 8 a.m. – 8 p.m. every day; real-time, optional small group sessions; grading of and feedback on written assignments; scheduled one-on-one counseling sessions; all course content in online form; supplemental guides and links to other resources; reporting and securing course credit, upon successful completion of the course, for inclusion in official transcripts by the physical school or district of record. FLVS also offers help desk (technical) support by phone and online.

K12 Inc.

www.k12.com

Founded: 1999
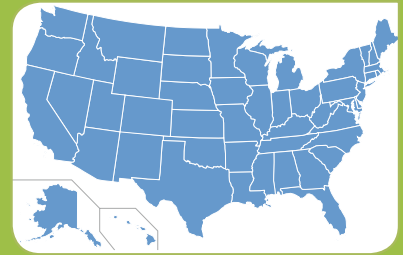
Based in Herndon, Virginia, K12 Inc. is among the largest providers of online courses at the primary and secondary level, with partnerships in about 2000, United States districts in 33 states. K12 offers more than 700 courses and titles for a general K–12 student population in English/language arts, math, history, science, art, and music, as well as Advanced Placement, world language, health and physical education, and elective courses at the high school level. Its subsidiaries, Aventa and A+ Anywhere Learning, offer additional courses geared toward at-risk students.

K12 partners with schools, districts, and states to create virtual school programs that meet local needs. In 2011–12, about 110,000 public school students enrolled in one of K12's courses in the United States, with an additional 30,000 private and international enrollments at the end of 2012. A summary of key findings are featured in the table below.

Algebra I

The two-segment course is available in three levels of difficulty and requires 6–9 hours of work per week for the average student. The CCSS-aligned version of the course is slated for Fall 2013 release.

Driving Standards	
Traditional (e.g., NCTM)	○
States	◐
Common Core	◐

Instructional Approach

Online teachers provide frequent feedback. Both teachers and adult mentors provide academic support and monitor progress.

Instructional Approach	
Teacher-directed	●
Student-directed	○
System-directed	◐

Media Design

The courses incorporate videos and animations of worked examples throughout each unit. Students work together to solve problems using virtual whiteboards. Teachers offer online tutoring sessions.

Media Design	
Read	●
Watch	○
Interact	◐

Assessment and Feedback

Formative, low-stakes quizzes are required at the end of each lesson. Larger unit assessments occur after each unit. Teachers assess unit tests before authorizing students to continue to the next unit. Teachers and students both use the Gradebook to monitor progress and performance.

Assessment	
Multiple-choice	●
Free-response	◐
Project- or performance-based	○

● Dominant ◐ Present ○ Absent/Minimally Present

Algebra I

The K12 Algebra I structure is similar to a traditional course with two segments (like semesters) that each have about nine units and 90 lessons in total. Enrollment is rolling but students assigned to the same section begin at roughly the same time. Students are expected to spend an average of 6–9 hours a week to complete Algebra I within a school year.

K12's Algebra I course comes in three variations. Comprehensive and Honors (which has project-based assignments) aim to prepare students for advanced math courses. Core focuses on basic graduation requirements and has a more flexible pace, attracting struggling 10th–12th grade students. Comprehensive Algebra I has the highest enrollments, with Core a close second.

K12 Algebra I follows a mastery model with a prescribed sequence. Teachers authorize students to move ahead after assessing student performance on assignments.

Driving Standards

Traditional (e.g., NCTM) ○

States ◐

Common Core ◐

Algebra I Enrollments

In Fall 2011, about 13,000 high school students and 7,000 middle school students were enrolled in K12's Algebra I.

Course Content

K12's Algebra I course was created by its team of in-house subject-matter experts, instructional designers, and multimedia developers. Similar to other providers using the mastery-based model, schools and districts have some ability to customize the standards covered, but cannot alter the sequence of course material. Typically, the Comprehensive version covers:

- Simplifying expressions involving variables, fractions, exponents, and radicals
- Working with integers, rational numbers, and irrational numbers
- Graphing and solving equations and inequalities
- Using factoring, formulas, and other techniques to solve quadratic and other polynomial equations
- Formulating valid mathematical arguments using various types of reasoning
- Translating word problems into mathematical equations and then using the equations to solve the original problems[24]

K12 emphasizes offering grade-level text and accessible content, style, structure, and design. They report that the Algebra I online text has a Flesch-Kinkaid reading level of 7.6, while the textbook has a level of about 6.4.

Anatomy of a K12 Lesson

Each lesson presents the lesson objectives and provides direct instruction and interactive activities around lesson content. During a typical lessons, students:

- Receive direct instruction in the form of animated videos that explain concepts;
- View worked examples illustrating proper solution strategy step-by-step;
- Engage with interactive animations (where they can manipulate variables and build an understanding of relationships);
- Watch "Math Casts" (videos of experts solving problems so students can model their process);
- Go offline, using their textbook and Student Guide to complete practice problems; and
- Take a quiz to demonstrate mastery and move on to the next lesson.

Standards Alignment

K12 reports that all their Algebra I courses can be aligned to state or local standards. Local adaptations may involve adding or removing course objectives, lessons, and/or activities. K12 has mapped their current Algebra I courses to Common Core State Standards (CCSS) and plans to release second-generation CCSS-aligned versions in Fall 2013. The new courses will incorporate foundational knowledge-building lessons before every unit, interactive manipulatives, more audio, and feedback designed to better reinforce concepts when students select wrong answers.

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24 http://www.k12.com/courses/high-school-courses/mth-123#.URAStegbqTA

Instructional Approach

Both online teachers and place-based mentors support students in K12 online courses. Teachers facilitate full-class online lectures and course discussions; track student progress; grade students' assignments; provide guidance and feedback; and support students by responding to questions (via phone or email), conducting tutoring sessions, and holding virtual office hours. Standardized course content frees teachers to focus on facilitating instruction, assessing understanding, and providing feedback for students—roles that K12 believes teachers are uniquely qualified to fulfill.

Instructional Approach

Teacher-directed ●

Student-directed ○

System-directed ◐

Supports for At-Risk Students

K12 provides multiple supports to monitor and support students' progress through the course. Generally students in K12 online courses must progress along with their class cohort, but the company also provides some flexibility with pacing. At enrollment, students and teachers agree on a schedule and develop a pacing guide that takes into account local deadlines (such as end-of-course (EOC) exams). The learning management system (LMS) alerts teachers, mentors, and the student if a student falls behind schedule. Teachers then intervene by contacting the student, providing tutoring, and/or meeting with a student's mentor or parent. For all students, the on-site mentors support student success by serving as a link between students and their online teachers.

K12 has also introduced the National Math Lab, a supplemental, not-for-credit, and optional program designed for students in Grades 5–11. It is meant to support students who are below grade level in math by identifying areas of need, providing live instruction, and using real-world problems.

Mentors at K12

All K12 students also have a mentor who monitors and encourages student progress. Mentors are usually district staff (for school-based students) or parents/caregivers (for students enrolled independently). Mentors receive a version of the Student Guide with information about course objectives and prompts for monitoring student progress. They also have access to the student's course materials and Gradebook.

Media Design

In Algebra I, each lesson includes Math Cast and other animated videos that provide direct instruction and worked examples of key concepts. As students progress through the course, they can use the navigation bar to review previous content as necessary.

Media Design

Read ●

Watch ○

Interact ◐

Teachers can interact with students individually, in small groups, and as a whole class using synchronous and asynchronous tools in the K12 courseware. Synchronous sessions employ third-party software such as Elluminate, and involve explanations, worked examples, or students solving problems using an electronic whiteboard. Some units end with discussion activities where students post their response to a prompt on a discussion board. These Raise Your Hand! discussion activities link to resources such as problem solutions and optional activities. Class discussion happens asynchronously since students work at different paces.

Students also complete "homework" offline, which K12 considers an essential part of the course. A Student Guide follows the course structure with lesson goals, materials needed, and key words for each lesson. It can be printed out or viewed on-screen.

Assessment and Feedback

Assessment

Assessment

Multiple-choice	●
Free-response	◔
Project- or performance-based	○

Throughout the course, students check their own understanding with ungraded practice and review problems. As students progress, the system prompts them to complete problem sets, which they may turn in for a grade (depending on local arrangements).

Each lesson concludes with a multiple-choice quiz or discussion activity. Quizzes count for a small percentage of a student's grade and serve as a formative indicator to both students and teachers. System feedback on quizzes shows students the correct answer but without an explanation or worked solution. Teachers can allow students to retake quizzes and provide remediation to students who perform poorly. Graded discussions are built into some lessons in lieu of quizzes.

Unit tests have both a computer-graded multiple-choice component and a teacher-graded written component. Teachers must provide students with feedback on the written component before students can proceed to the next unit. K12 provides teachers with worked-out solutions plus a scoring rubric for each test in order to save them time and allow them to focus on assessing mastery, providing feedback, and tailoring instruction.

K12 Virtual Academy students in Grades 3-12 take Scantron's Performance Series tests as they enter school and again at the end of the year. This test is used to establish a baseline measure of student understanding, inform teachers' individualized learning plan for each student, and measure student growth over the year.[25] In K12-managed public schools, district staff is responsible for administering locally.

Feedback

Feedback

System-generated accuracy	●
System-generated explanation	○
Teacher-generated	◔

Teachers, mentors, and students have access to a Gradebook and Pacing Guide via the LMS. The Gradebook shows students' quiz grades, time spent on each lesson, work completed, and answers to specific assignments. The Pacing Guide shows how each student is progressing in relation to their goals for progress as established at the outset.

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25 http://help.k12.com/support-topics/ols-online-school/virtual-academyvirtual-school-program/k-8/scantron-tests/scantron-0

Other Considerations

Most of K12's enrollments are through full-time virtual schools established in partnership with schools or districts. In this model, K12 provides curricular materials, professional development, technical support and other consulting to the school or district running the program. Students can also enroll directly with K12 by purchasing their courses online for independent study, enroll in one of K12's online private schools, or enroll online parttime through their school or district.

The company serves students in Grades K–12. Their online public school accepts all students, and K12 reports increasing enrollments from struggling students who are retaking a previously failed course. The K12 private schools (e.g., K12 International Academy, The George Washington Online High School) have selective admissions and tend to attract accelerated students.

Professional Development

Teachers at K12's full time public schools have subject-area certification in the states where they teach. K12 does not actively recruit teachers with online teaching experience, but all teachers receive training and on-going professional development. K12 also provides training in online teaching for local teachers using the curriculum, as well as a hotline to answer teachers' questions about curriculum, instruction, and tools.[26]

Enrollment

Enrollment processes vary according to how K12's courses are implemented by the local user. Parents may purchase courses or enroll students directly through K12's online site if they are completing courses as an independent study. For enrollment in K12's full-time private programs, students must apply for acceptance into the programs. For enrollment in any of the public school partnerships, students must enroll (or in some cases, apply) in coordination with the school's representatives.

K12 offers an informational online learning assessment in the form of a 10-minute interactive tutorial to help students and parents determine whether a K12 online school is right for them. [27]

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26 http://www.k12.com/educators/services/professional-development

27 http://quiz.k12.com/

Orientation

First-time K12 students complete a precourse training that introduces online learning. The course sets expectations for student behavior, provides guidance on skills such as time management and organization, and gives an overview of K12's course features. Within each course, a shorter introduction tailored to the specific course covers similar topics.
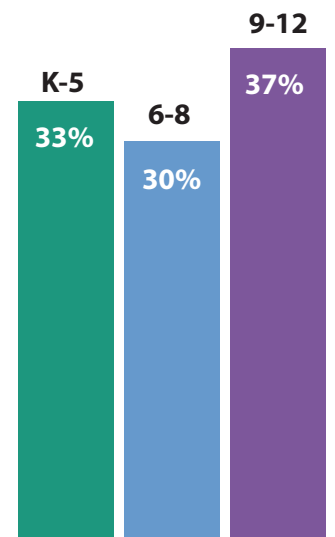
Enrollment in K12-managed public schools*

*2013 K12 Academic Report. (2013). http://www.k12.com/sites/default/files/pdf/2013-K12-Academic-Report-Feb6-2013.pdf.
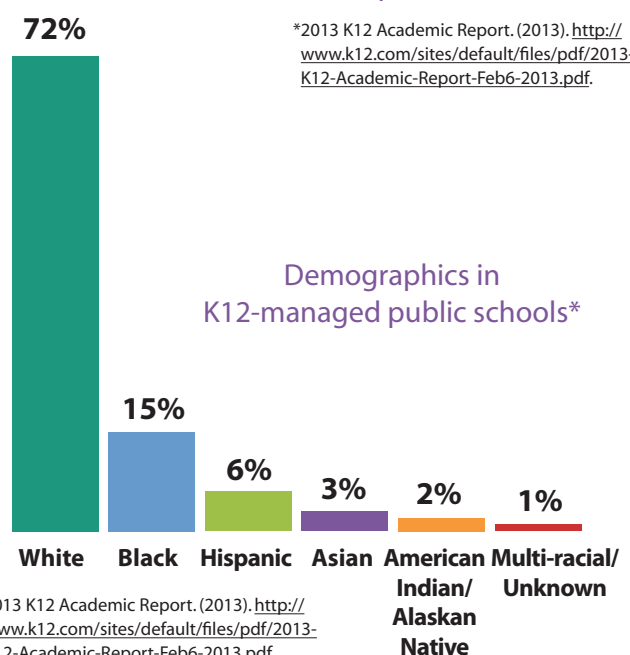
Demographics in K12-managed public schools*

*2013 K12 Academic Report. (2013). http://www.k12.com/sites/default/files/pdf/2013-K12-Academic-Report-Feb6-2013.pdf.

Technology

- **Operating systems:** Courseware can be accessed on both Windows and Mac.

- **Browsers:** Internet Explorer 7, 8, or 9; Firefox 3.6, 4.0, or higher; Google Chrome 17.0 or higher (additional supports or programs operated outside of K12's online courseware may have other requirements)

- **Required software or plug-ins (all free):** Adobe Acrobat Reader, Real Player, Flash, and QuickTime

- **Connection speed:** K12 strongly recommends using a broadband connection.

- **Additional equipment:** K12 provides computers and scanners to its managed virtual schools.

- **Devices:** The digital textbook can be downloaded as a PDF, and as a result, is compatible with any computer or mobile device that is capable of reading PDFs (e.g., tablets, e-readers). However, the courseware itself is not currently optimized for mobile devices. [28]

Cost

Students do not pay per course for enrollments through K12-managed public schools or districts or through K12 online, tuition-based private schools. For the virtual public school partnerships, K12 provides computers and scanners as part of the bundled cost of the course(s). K12 provides a free technical support hotline number and Customer Support site that students can access at any time for technical assistance.

Individual enrollment in an Algebra I (Core, Comprehensive, or Honors) semester costs $425.00, plus an additional $62.00 for the course reference guide and problem sets.[29] Discounts may be available based on purchase volume, sibling enrollments, and prepayment.

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28 http://www.k12.com/faqs/Technical

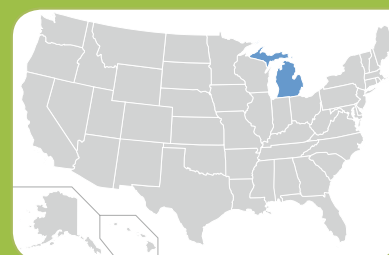29 https://ecomm.k12.com/ecommerce/public/courseDetails.xhtml?cid=772843

Michigan Virtual School

mivhs.org

Founded: 2000

The Michigan Virtual School (MVS)—operated by the Michigan Virtual University, a private, nonprofit organization established by state legislature in 1998 —was created in 2000 to provide supplemental online learning resources for Michigan's schools. In the 2011–12 school year, MVS reported 18,756 course enrollments (14,379 of which were in Plus courses) from 11,621 unique student accounts. MVS draws its students almost entirely from Michigan and most students are either secondary students who are located in a physical school or home-schooled.

The public virtual school offers three primary types of courses: Basic, Blended, and Plus. Both Basic and Blended courses are delivered in partnership with Apex Learning,[30] and the Blended courses provide a supplemental content-only resource for teachers in schools. MVS Plus courses, developed in-house or supplied to MVS through third-party licensing, are delivered by MVS's teachers in the online environment. (In general, the practices described here pertain to the Plus courses; see the Apex Learning Profile for more information on Apex's course models). A summary of key findings are featured in the table below.

Algebra I

Algebra I lessons integrate supplemental resources from a variety of different external sites (e.g., NROC, Gizmos, BrainPop), each intended to provide instruction and reinforce concepts. MVS courses are in the process of being aligned to the CCSS.

Driving Standards	
Traditional (e.g., NCTM)	◯
States	●
Common Core	◓

Instructional Approach

MVS courses use a mastery model that allows students to progress by demonstrating their understanding of content. Teachers monitor student activity, providing feedback on assignments throughout the semester and intervening when students fail to advance in the course at an appropriate pace or report that they are experiencing difficulty with the content.

Instructional Approach	
Teacher-directed	◯
Student-directed	●
System-directed	◯

Media Design

Each lesson contains links to one or more of the following media elements: e-textbooks, video tutorials, animations, interactives (e.g., graphers), and images. Separate logins are required to access most of the interactive media content.

Media Design	
Read	◯
Watch	◯
Interact	◯

Assessment and Feedback

MVS offers formative and summative assessments. Checkpoint quizzes and unit tests are computer-scored and provide feedback on correctness of the response upon completion. In Algebra I, students can move forward in the course only when they have passed graded assessments at each checkpoint and at the end of each unit.

Assessment	
Multiple-choice	●
Free-response	◯
Project- or performance-based	◯

● Dominant ◯ Present ◯ Absent/Minimally Present

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30 Courses offered by Apex Learning are currently being phased out of MVS offerings.

Algebra I

MVS offers Algebra I across all three types of courses (Basic, Blended, and Plus), and an additional option that allows students to take an online review course without an instructor in preparation for "testing out" of the course. The MVS Plus Algebra I course typically has two semester-long segments that operate on an 18-week semester schedule; a 12-week trimester or 8-week accelerated or summer school schedule are also available.

The MVS Plus Algebra I course uses a mastery model with an "adaptive release" structure whereby students must pass each checkpoint quiz (after groups of lessons) and unit test (at the end of each unit) with a 60% or more in order to progress to the next lesson or unit.

In the 2011–12 school year, 540 students enrolled in Algebra I across all three types of MVS courses.

Course Content

A typical MVS Plus Algebra I lesson consists of a reading, practice problems, and tutorial videos in the Holt e-textbook. Each lesson also includes supplemental resources that present the same content in different ways.[31] Students can select from amongst these optional supplemental resources to find materials that best suit their needs. Instructors may also refer students to resources outside the course to further individualize instruction. While the course pacing may be adjusted, its sequence may not.

MVS is unique in providing multiple resources covering the same content. These materials offer students individualized learning options and multiple opportunities to review the material. However, the multitude of resources, each with different formats and procedures, could prove challenging for students to navigate. Apart from an overview of available resources, the MVS courseware does not provide guidance about the resources; instead online instructors are expected to guide students.

Standards Alignment

The MVS Plus Algebra I curriculum for 2012–13 is aligned to the Michigan Merit Curriculum, with plans for aligning MVS Plus courses to CCSS. MVS anticipates that a CCSS-aligned Algebra I Plus course will be available for fall 2013. The MVS instructional design team has mapped their course to the CCSS standards and suggests that the biggest changes required for alignment relate to the CCSS practice standards (versus the CCSS content standards).

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31 These optional resources consist primarily of resources from third-party educational sites such as BrainPop, the National Repository of Online Courses (NROC), and online math simulations called Gizmos.

Driving Standards

Traditional (e.g., NCTM) ◯

States ●

Common Core ◯
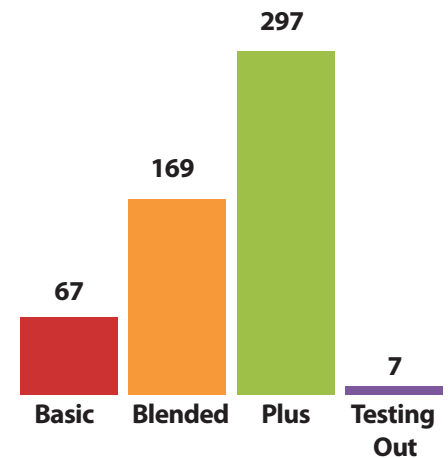
MVS Algebra I Enrollments (2011–12)

Anatomy of an MVS Algebra I Lesson

Both segments of MVS Plus Algebra I (A and B) have an introductory unit followed by five and four content units, respectively. Each unit consists of 8–10 lessons aligned to Michigan content standards and organized around the Holt e-textbook. Each lesson will prompt the student to:

• Read a section of the Holt e-textbook; there they can also watch Lesson Tutorial Videos, complete a Practice Quiz, and consult the Homework Help section for more practice problems and explanatory text;

• Participate in a series of supplemental activities, such as Gizmo or BrainPop; and

• Complete a checkpoint quiz (after every 1–3 lessons).

Many of the supplemental resources, including the Holt e-textbook, are available through external sites and may require separate logins.

Instructional Approach

Instructional Approach

Teacher-directed ○

Student-directed ●

System-directed ○

The primary role of MVS Plus teachers is to monitor student activity, provide feedback on assignments throughout the semester, and provide supplemental instruction and assistance when students fail to advance in the course at an appropriate pace or report that they are experiencing difficulty with the content. Students typically seek support from the MVS teacher when they need help; similarly, teachers only intervene when students are behind on assignments or are receiving poor grades, allowing them to focus their efforts on students who need their assistance most.

MVS does not have requirements for how often teachers and students must interact (as long as students are progressing adequately); however, they do monitor all teachers regularly, including turn-around time for student emails and assignments, participation in discussion board threads, and follow-up with disengaged students.

Supports for At-Risk Students

MVS indicates that mentors play a critical role in supporting at-risk or struggling students at MVS, in part because of their physical proximity to the student. While MVS staff often has no means of contacting a student outside of the course management system, they can always contact the school staff serving as mentors. Mentors can also support MVS educators in tracking and encouraging student progress.

MVS Algebra I students complete a required subject-specific course overview that introduces them to the structure and content of the course. Weekly pacing guides offer suggested timelines for lessons and graded assignments, and help ensure students are making adequate progress. Teachers intervene when students fall behind; teachers and students can also adjust the pacing to suit individual needs.

Mentors at MVS

MVS students enrolled at local schools must have an on-site mentor to provide additional support to the student and serve as a liaison between the student, school, and MVS staff. Mentors must be accredited instructors, although they do not need to have certification in the subject area of the course the student is taking through MVS.

Finally, MVS considers readability when selecting a textbook for a course, comparing textbooks and selecting the one they believe is most appropriate for their student population.

Media Design

Media Design

Read ○

Watch ○

Interact ○

The supplemental resources from the Holt e-textbook, HippoCampus and National Repository of Online Courses (NROC) that accompany each lesson offer multiple media elements for students. Holt provides instructional videos where an instructor completes worked examples of problems pertaining to the lesson content. HippoCampus provides practice problems that students can first try independently; if they need help they can watch videos showing how to solve them. The NROC Lessons provide an entire additional lesson on the same topic that students can work through if they choose. Each NROC lesson includes a warm-up; a presentation (a video showing an instructor explaining the topic); worked examples; practice problems; and a review section (with more problems for students to solve).

For subject matter or assignment questions and issues, students can contact their teachers either through the online system or via personal communications such as cell phone or Skype. Though atypical of Algebra I, teachers sometimes use the Adobe Connect collaboration tool to supplement instruction through real-time practice and tutoring sessions with students.

Assessment and Feedback

Assessment

Assessment

Multiple-choice ●

Free-response ○

Project- or performance-based ○

The MVS courseware contains both formative and summative assessments. Each lesson includes practice problems from the Holt e-textbook (which provides immediate feedback about the correctness of the response) and within the supplemental resources. Checkpoint quizzes (after a group of lessons) and unit tests (at the end of each unit) consist of computer-scored multiple-choice questions. Students must pass these assessments with a grade of 60% or more in order to move forward in the course; students who do not pass must contact their teacher for assistance. Students have two attempts to take the checkpoint quizzes (unless the teacher unlocks the quiz to provide unlimited attempts). MVS Plus Algebra I uses the Maple T.A. assessments system[32] to generate checkpoint quizzes with different versions of the problems for each attempt; the system also provides immediate feedback to students on the correctness of their responses.

Unlike some states, Michigan does not require a comprehensive, end-of-course (EOC) exam for Algebra I to receive credit for the course.

Feedback

Feedback

System-generated accuracy ●

System-generated explanation ○

Teacher-generated ○

The "My Grades" section of the site contains student grades on the Maple T.A. assessments, and recent activity from both teachers (i.e., feedback) and students in each assignment. Students can also view points earned out of total points in a course, assignments they have attempted, and what their grade would be if they did not complete any more assignments in the course. At least twice a semester, regardless of their progress, students (and their mentors) receive an email progress check from their instructor detailing their performance in the course so far.

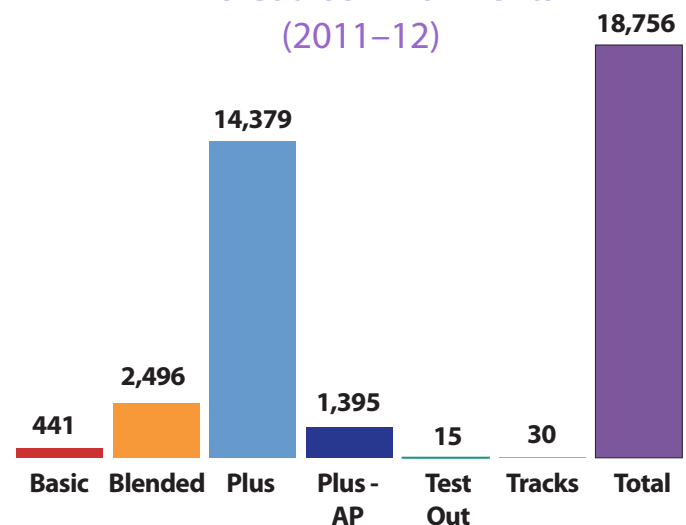32 www.maplesoft.com/products/mapleta

Other Considerations

Schools and students typically rely on MVS to supplement local course offerings. (Indeed, many schools in Michigan do not allow students to enroll in MVS courses if the face-to-face version is offered locally.) Most students log into their MVS courses from a school computer lab and complete their courses without significant school-based instruction. Michigan requires each student to have an on-site mentor, who is a certified instructor (though not necessarily in the subject being taught) responsible for supporting the student and serves as a point of contact for MVS teachers and administrative staff. [33]

MVS does not grant credit to students. The local administration at each school or district is responsible for credit evaluation and transcription.

MVS Course Enrollments (2011–12)

Basic	Blended	Plus	Plus-AP	Test Out	Tracks	Total
441	2,496	14,379	1,395	15	30	18,756

MVS mostly serves high school students (79% of MVS courses), though they offer some middle school courses. A majority of MVS students are also enrolled in Michigan local educational agencies, public school academies, intermediate school districts, and nonpublic schools (84%); the remaining student registrations are from home schools (16%).[34] In 2011–12, 53% of students were female, and 47% were male.

Professional Development

All new MVS teachers participate in an online training (beginning with a face-to-face session) that introduces them to the major learning management system (LMS) and provides basic starter tips. Teachers then participate in a 4 week Online Instructor Training (OIT), which has four modules: getting organized, providing feedback and communication, using multimedia, and continuing the instructor discourse. Teachers also participate in ongoing PD throughout the academic year, including 2 day in-person meetings at MVS offices (called "Collaboration of the Minds"), optional quarterly professional development (hosted in various parts of the state), and monthly webinars hosted by instructional staff.

MVS provides training to mentors in a particular district or area upon request. Michigan LearnPort, the other division of Michigan Virtual University, is another resource for both online teachers and teachers in physical schools: it provides online professional development and curriculum resources to teachers across the state, regardless of whether their students are enrolled in MVS courses.

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33 This requirement comes from Michigan's Pupil Accounting Manual, available at http://mi.gov/documents/5O-VirtualHS-DistLearning_41466_7.pdf.

34 172 of 18,756 enrollments were from out of state and are not included in the enrollment breakdown.

Enrollment

Students must sign up for MVS courses directly through their local schools or districts. MVS Plus courses have multiple enrollment periods, with fixed completion dates to correspond with the traditional academic semester. Due to this rolling schedule and the mastery-based structure of the courses, students work largely independent of other students in their course section.

Orientation

Each MVS Plus course, including Algebra I, contains optional, course-specific orientation videos that provide an overview of how to navigate the course website, complete work, and read the grade book.

Technology

- **Operating systems:** Firefox, Internet Explorer, and Safari
- **Required plug-ins (all free):** Java and Flash plugins are required.
- **LMS:** MVS courses are delivered through Blackboard.
- **Connection speed:** MVS strongly recommends that students connect with broadband (cable, DSL, or satellite) Internet access.
- **Additional equipment:** Representatives note that most computers purchased within the last 5 years have the speed and capabilities to support their courses. Some courses require additional hardware, such as a CD-ROM drive or sound card.

Cost

The per-semester cost of MVS courses depends on the course variation purchased (Plus, Basic, or Blended) and whether the purchaser is in-state or out-of-state. Additional discounts are available to Michigan districts in consortiums or those purchasing more than $6,000 in licenses. Select MVS courses may require supplemental materials or equipment, and MVS provides a help desk hotline and ticketing system to answer technical questions at no additional cost.

2012–13 Course Cost per Semester

	MVS Plus	MVS Basic	MVS Blended
Base Price	$275	$190	$99
Out-of-State	$410	$275	$200

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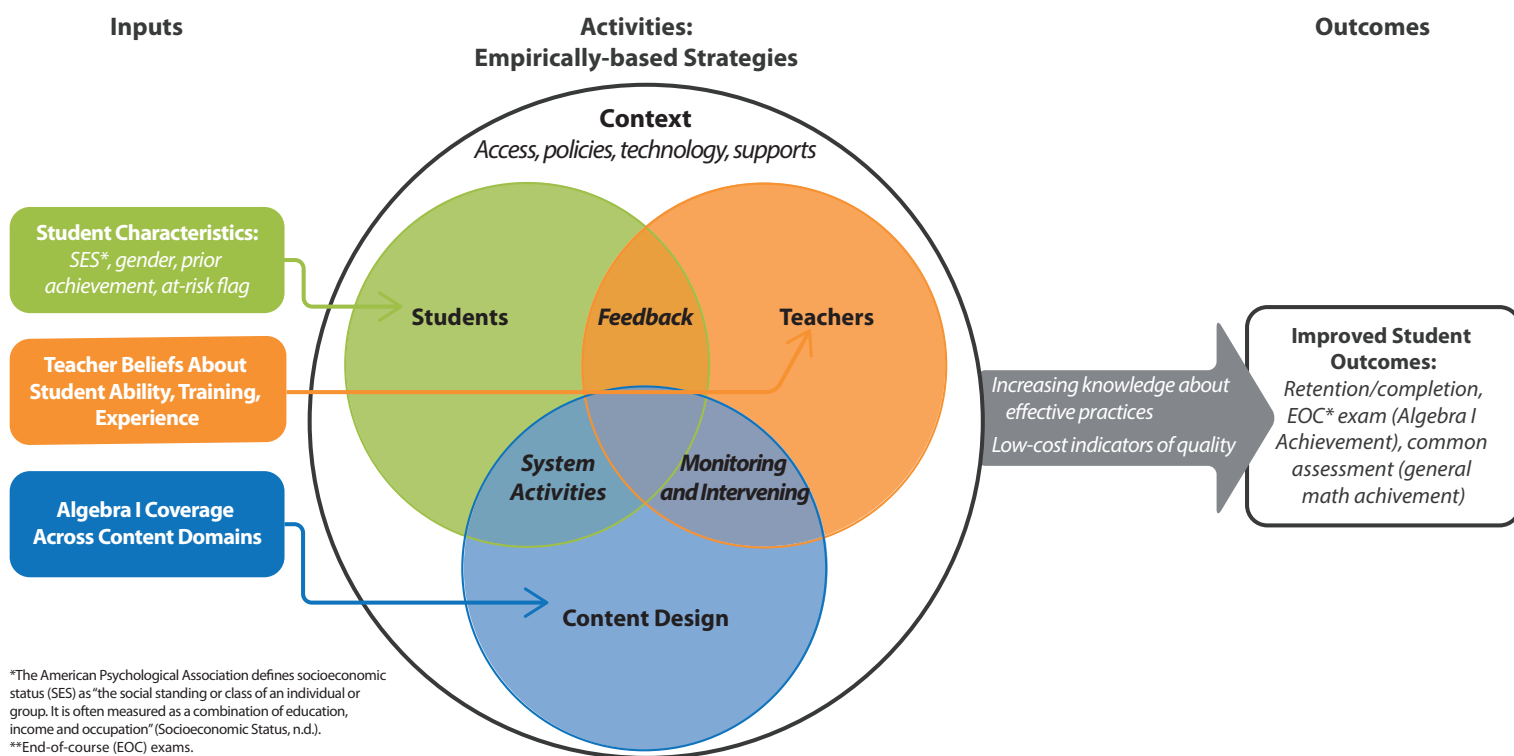
Appendix A: Literature Review

Topics covered in the Provider Profiles were derived from a review of the literature regarding the relationship between the characteristics of the student, teacher and instructional material, and student learning outcomes in online learning. The intent of this literature review was to connect research across disciplines to inform the selection and measurement of the design and implementation features of online courses that are associated with critical academic outcomes for students. These critical outcomes include improved algebraic reasoning and understanding of Algebra I content, and ultimately successful course completion.

The search primarily focused on research that discussed at least two of the three areas identified as being especially pertinent to the current study: Algebra I education, at-risk students, and characteristics of successful online courses. Resources were identified via an Internet-based search and expert nominations. An emphasis was placed on meta-analyses, research syntheses, seminal research, and studies that used an experimental design.

Conceptual Framework for Unpacking Course Quality

To guide our literature search, we created a framework for understanding key elements of the course system (Exhibit A1). When students take online courses, three elements—*student characteristics, teacher characteristics,* and *course content*—interact within the course-taking context. Whether students take the course in school or independently, students' technology access, and provider and district policies, all contribute to the context.

Exhibit A1: Guiding Questions for Selecting an Online Course

Inputs

**Activities:
Empirically-based Strategies**

Outcomes

Context
Access, policies, technology, supports

Student Characteristics:
SES*, gender, prior achievement, at-risk flag

Teacher Beliefs About Student Ability, Training, Experience

Algebra I Coverage Across Content Domains

Students

Feedback

Teachers

System Activities

Monitoring and Intervening

Content Design

Increasing knowledge about effective practices
Low-cost indicators of quality

Improved Student Outcomes:
Retention/completion, EOC* exam (Algebra I Achievement), common assessment (general math achivement)

*The American Psychological Association defines socioeconomic status (SES) as "the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation" (Socioeconomic Status, n.d.).
**End-of-course (EOC) exams.

The *interactions* among students, teachers, and course content are depicted in the framework as areas of overlap. The idea of interactions taking place in a context underscores our perspective that the study of online courses should include analysis of not just the software, but of how people use it, under what circumstances, and with what results.

Students interact with the content in *system activities*, which are shaped by how the content is presented or designed, as well as by the students' characteristics, including prior knowledge and motivation. Teachers interact with the courseware to monitor students' progress and possibly to supplement instruction. And teachers and students interact through teachers' *feedback* on progress and students responses to that feedback.

Literature Review Summary

The conceptual framework presented in Exhibit 18 above is used to organize the results of the literature review presented below. Specifically, summarized results from the literature review are organized within the following main topics: Student Characteristics, Teachers and Instructor Involvement, Material Design and Course Content, and Pedagogical and Instructional Strategies.

Student Characteristics

Because success is likely dependent on a complex array of factors, we reviewed literature addressing the relationships between various student characteristics and success in online learning and math achievement. A review of the literature regarding the relationship between noncognitive abilities and academic performance was included. Three types of student characteristics relevant to our current research were identified: demographic, cognitive, and noncognitive.

In the literature, *student demographics* are typically broken down further into four subcategories: gender, socioeconomic status, ethnicity, and enrollment status. With the exception of enrollment status, the literature suggests that the other three demographic characteristics are significant predictors of success in online learning. In both online and traditional algebra courses, gender has been found to be a significant predictor of success with differences being particularly pronounced among the highest-performing students. Additionally, student participation in free or reduced-price lunch programs is negatively associated with success in online courses, while significant achievement gaps between students of different ethnicities have also been observed. Enrollment status was also included due to the rising concern in the media regarding the efficacy of online learning.

Regarding *student cognitive characteristics*, prior academic performance is considered a strong predictor of student success in both online and traditional learning. Specifically, GPA and other pretests have been found to be strong predictors of success in online courses and algebra courses.

The literature suggests that several *noncognitive abilities* are significant predictors of success in virtual courses, including technology use and self-efficacy, achievement beliefs, instructional risk-taking, and organization strategies. More recently, sophisticated learning management systems (LMS) have made it possible to identify other noncognitive abilities in real-time. Studies using LMS systems have been able to measure student engagement by tracking their interaction with the online course materials. Studies have also identified motivation, beliefs about achievement, and self-regulation as predictors of success in online learning.

Teachers and Instructor Involvement

A review of the literature suggested that, as with traditional face-to-face instruction, differences in online learning opportunities can be attributed to differences in teacher performance, such as teacher knowledge, experience, and actions. Key teacher attributes include: beliefs and expectations, professional development to teach online, use of data, and communication and feedback.

Research has shown that *teachers' experience,* test scores, regular licensure/credentialing, and National Board Certification have positive effects on students' math achievement. One synthesis of literature relating to best practices in online education found empirical support for requiring online instructors to meet credentialing and licensure requirements. Another study that looked at longitudinal data on student achievement in mathematics supported the hypothesis that proxies for content knowledge, such as having a bachelor's degree in mathematics, as well as teacher certification, were related to achievement growth.

Many studies have also shown that *teachers' beliefs and expectations* regarding their own students can have significant impacts on their teaching. For example, research has shown that teachers are more likely to emphasize higher order thinking with high-performing students than with low-performing students. Additionally, stereotypes around gender and mathematical abilities have been observed in teachers who show higher expectations for male students by overrating male students' capabilities and underrating their female counterparts.

Furthermore, while some research has shown that *professional development* can have a positive impact on student achievement in traditional classroom instruction, the literature contains mixed results regarding the effects of professional development specific to online instruction on student achievement. While one meta-analysis of the effusiveness of distance education found no significant effect of professional development, another synthesis of best practice documents in virtual schooling found numerous articles supporting online teachers participating in pre-service and in-service professional development as a criterion. The literature also identifies training in online teaching as one type of support requested by faculty.

Additionally, studies suggest that continual *communication and feedback* between instructors and students has a positive effect on achievement. Such communication and feedback can be facilitated greatly through the use of LMS that provide instructors with real-time data on student performance and variance among students. This use of data is viewed as a way of individualizing, or personalizing, instruction for students, and has been observed to boost achievement in online learning environments.

Material Design and Content

Due to the fact that there is little empirical research that has addressed either the design of online math courses specifically or designs that are particularly effective with at-risk populations, we reviewed the research on general effective course design in online learning. Elements of quality design identified in our literature review include: sequence and learner control, pacing, advanced organizers and supplemental materials, media elements, and embedded assessments.

Both *sequence*, the order in which content is presented, and *learner control*, the amount of freedom a learner has to move throughout the lesson, can impact achievement outcomes. Research has shown improved learning when subject matter was presented in a predetermined sequential order and with low to medium amounts of learner control. However, a detrimental effect has been observed on learning when students were allowed to jump freely from one topic to another. In a similar vein, several studies have observed that allowing students a greater degree of control over the pacing, or how quickly they move through the content, of their lessons outperformed those who had no control.

Tools for pacing suggested in the research include student checklists, self-tests, and orientation programs, but these have not been substantiated by rigorous evidence-based support. While there is research to support the view that the availability of advanced organizers and supplemental materials has a positive impact on achievement, one meta-analysis found that the availability of printed or supplemental material was not related to learner achievement.

Media elements, such as on-screen text or spoken audio, have also been observed to have a positive effect on performance, but the use of redundant text and gratuitous visuals, text, and sound has been observed to have a negative effect. One study found that simultaneous narration and animation had a redundancy effect that caused learners to split their attention between one and the other, thus inhibiting their ability to retain complex concepts.

Several meta-analyses reviewed stress the importance of *embedded assessments* to provide frequent learning opportunities through practice exercises, including tools that prompt students to reflect on their learning. For example, studies that looked at automated scoring systems that give students immediate and targeted feedback on mistakes made both during and after practice assignments have suggested a dose-response effect, such that the course became more effective the more students used it.

The literature on *curricular coherence* emphasized the notion of tying mathematical instruction to a core set of big ideas that are revisited throughout the curriculum, and suggests that the relative lack of such a structure in the United States has played a role in the poor U.S. standing in international mathematics assessments and the strong link between achievement and socioeconomic status. While the Common Core State Standards (CCSS) for Mathematics has been constructed to provide a "big ideas" framework, neither Algebra I nor Common Core Standards-Based Algebra I signals a fixed body of learning objectives and corresponding achievement metrics.

Instructional Strategies

Multiple instructional strategies have been developed to improve student success in mathematics courses, and other strategies have been developed to improve student success in online courses. Instructional strategies developed specifically for algebra content include instructional focus on understanding; "genuine" mathematics content; metacognition; multiple, linked representations; and learner adapted-pedagogy.

The literature reviewed for this study lays down a foundation of evidence for using the instructional strategies mentioned above. A meta-analysis on instructional focus found that a focus on understanding had almost twice the effect as one on procedure. Research also suggests that stressing students' understanding and application of mathematical concepts, as opposed to learning an arbitrary collection of facts and rules, leads to higher competency. Making mathematical concepts more accessible and tailored towards individual learning has also been observed to increase learning, adding to the importance of multiple, linked representations, learner-adapted pedagogy, and support for at-risk students.

While simply requiring instructors to interact with students individually throughout lessons has been demonstrated to be helpful to students, this effect can be increased further through the use of real-time data obtained by an LMS. By having access to student performance data in real-time, the facilitator can focus attention on the individual needs of struggling students, as well as use it to motivate students to achieve completion of the course. Finally, in order to overcome some of the challenges that online learning presents, research has shown that creating small learning communities can help decrease psychological isolation of students and encourage student-to-student interactions that have been demonstrated to facilitate increased learning.

Educational Context

Researchers hypothesize that there are implementation characteristics and other policies (such as the availability of student orientation, technology access, and technical support) that seem well positioned to contribute to student success in online courses. Because many students may be new to distance learning, and thus unprepared for the challenges associated with it, requiring students to complete an orientation at the beginning of a course has been shown to increase their likelihood of success. Due to the reliance on technology in fully online course environments, the literature demonstrates that it is critical for students to have sufficient access to technology, including adequate Internet connectivity and the ability to access work off site. On the course facilitator's end, it is important that instructors be provided with technical support from an IT staff in order to prevent any technology-related hurdles to learning.

Appendix B: Methods

The review of online Algebra I offerings was based on a purposeful sample of online Algebra I course providers. Appendix B describes our process for identifying and selecting providers for participation in the study.

Overview of Participating Providers

The world of online math software is expanding rapidly. New applications, games, and software designed to help K–12 students learn mathematics emerge every day. Many of these products—including fairly comprehensive offerings such as Khan Academy's instructional videos and Dreambox Learning's adaptive learning software, as well as newer game-like applications such as Operation Math and Doodle Learning Maths—target specific concepts or skills (e.g., multiplying radical expressions) and are intended for use as part of a blended learning experience, or one in which students receive a portion of their instruction both online and in a face-to-face environment (such as a school).

For this report, researchers looked at a set of products called online courses. Online courses, as defined here, are used in many states and districts in lieu of traditional, classroom-based curriculum. Students who complete appropriate online courses successfully receive credit toward graduation requirements. Because we focus on credit-bearing, fully online courses, some of the newest entrants into the world of online math resources, such as Khan Academy and Mathalicious, are not included in the review.
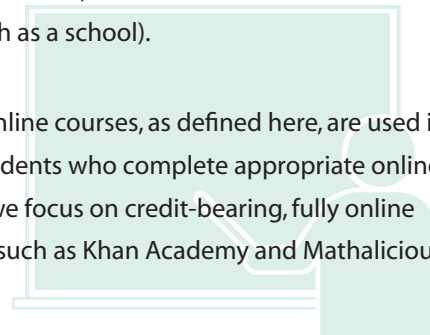
Provider Selection

SRI collected internal resources from prior research, along with resources recommended to us by experts at the International Association for K–12 Online Learning (iNACOL), including their report 2011 Keeping Pace with K–12 Online Learning: An Annual Review Report of Policy and Practice (Watson, et al., 2011), to develop an initial list of online course providers. Various data sources were merged and duplicates were removed, resulting in a total of 121 candidate providers.

Research team members conducted a preliminary review of each candidate's website, and in some cases, conducted a short telephone screen when only limited information regarding the provider's scale of operation and course offerings was available. Providers that solely offered supplemental materials were removed from the list (e.g., online textbook suppliers), as were nonsecondary providers. Remaining providers were prioritized based on the available information about enrollments and geographic reach. Eligibility criteria are summarized in Exhibit B1.

Exhibit B1: Guiding Questions for Selecting an Online Course

1. Operate on the national or state level
2. Offer at least one fully online, credit-bearing Algebra I course to secondary students in the 2012–13 academic year
3. Have minimum enrollments of 200 students enrolled in Algebra I in the 2012–13 academic year

SRI contacted 16 course providers via phone and email to determine if they were involved in online high school Algebra I courses that met study criteria, including minimum enrollments of 200 students in at least one fully online, credit-bearing Algebra I course to secondary students. We also sought providers that operated at the national or state level. Out of 16 course providers, 6 providers (Apex Learning, Class.com, Edgenuity, FLVS, K12, and MVS) both met study criteria and agreed to participate.

Research Approach

This report is based on a case-study approach that examined courses and associated course practices within and across course providers. Data for the report are largely qualitative, based on two primary sources: interviews with course providers and systematic reviews of course materials. Study instruments and protocols were developed after a literature review that identified a range of policies and practices that appeared to be associated with academic outcomes.

Interview and Website Review

To better understand the nature of each provider's offering and particulars of their approach to and philosophy of online learning, we developed and uniformly used a standardized interview protocol with knowledgeable representative(s) of each provider.

Because of the volume of information being collected, two interview protocols were developed for an initial provider screen interview and a follow-up interview. The Initial Provider Screen Interview Protocol was used with providers identified in the Initial Provider Scan who agreed to participate in a 1-hour phone interview to introduce them to the project, conduct an initial screen for the providers' eligibility, collect information about their Algebra I offerings, and begin to recruit and negotiate participation in the study as appropriate. The Provider Follow-Up Interview Protocol was used during a 60–90 minute interview to learn more about policies and supports in place for students and teachers, as well as what providers see as the greatest challenges in supporting at-risk learners in online environments and the strategies they use to overcome them. In some instances where time was limited, the two interviews were conducted as one, or several separate interviews were conducted with various staff, such as instructional designers, administrators, and course instructors.

Transcripts of the interviews supplied data to inform the construction of each provider's profile and were corroborated through a spot-check examination of the course website. As the study progressed, course providers also responded to additional clarification questions about course design and use, which were usually sent by email.

Independent Courseware Review

Review Checklist

A checklist was developed to identify the presence of features within each course. The checklist had two sections: a course-wide component and a lesson-level section. The course-wide section included information in the following categories: (1) opportunities to use data, (2) structure, (3) strategies to support at-risk students, and (4) advanced organizers and supplemental materials. Under each category, we included specific features. For example, under opportunities to use data, we examined whether a course site provided opportunities for teachers to view real-time student data and whether data were presented to help instructors identify and closely monitor students at-risk of academic failure. The lesson-level section had information organized into the following categories: (1) sequence and learner control; (2) advanced organizers and supplemental materials; (3) media elements; (4) assessments, feedback, and practice exercises; and (5) the Common Core State Standards (CCSS) mathematical practice standards. Both sections also included several columns addressing how the features operated within each course. For example, we noted whether the feature was engaged synchronously or asynchronously, system- or teacher-directed, mediated by specific tools (e.g., a discussion forum, blog, wiki), or provided through specific media (e.g., animation, video, audio).

We developed the checklist based on information from the literature about features with demonstrated efficacy for students who struggle in online Algebra courses; features for students struggling with mathematics more generally; and features to support learning in the online environment more generally. Thus, some features included in the checklist came from findings about traditional classroom environments specifically, but were important for creating supportive online learning environments as well. For example, noncognitive strategies aimed at improving a student's sense of social belonging, positive social messaging, and providing mentors to students were all strategies that have proved valuable in traditional classroom settings and that we included in our checklist. Other features in the checklist were more specific to online learning environments. For example, communication methods and timeliness, students' control, and overall pacing are often structured specifically to accommodate online learning.

Next, we selected two topics that we could compare across providers to complete the lesson-level section of the courseware review: (1) understanding completing the square and using it in solving quadratic equations, and (2) understanding the standard form of linear equations and using it to aid in graphing. We used the CCSS to guide our lesson selection because the CCSS are becoming an accepted reference for describing the content and pedagogical approach found in instructional materials. The lessons had to cover the same content to ensure that any differences we encountered across providers reflected true differences in the providers and their courseware (and did not result from content differences).

To select the lessons, internal experts identified five CCSS items that were each plausible to address in a single lesson, central to Algebra (thus more likely to appear in these courses), and relatively challenging (such that more interesting instructional approaches might emerge). See Exhibit B2 for details about the five lesson standards selected.

Exhibit B2: Common Core State Standards Selected for Courseware Review

Domain	Selected Standard
The Real Number System: Extend the properties of exponents to rational exponents.	N-RN.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.
Interpreting Functions: Understand the concept of a function and use function notation.	F-IF.7a: Graph linear and quadratic functions and show intercepts, maxima, and minima.
Creating Equations: Create equations that describe numbers or relationships.	A-CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
Reasoning with Equations and Inequalities: Understand solving equations as a process of reasoning and explain the reasoning.	A-REI.4a: Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x − p)2 = q$ that has the same solutions. Derive the quadratic formula from this form.
Quantities: Reason quantitatively and use units to solve problems.	N-Q.1: Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Starting with the first CCSS item, the team looked through the Algebra I course for each provider to identify a lesson that uniquely addressed that item. If a provider did not have a lesson addressing that topic, we discontinued the search with that item, dropped it from consideration, and started anew with the next item on the list. None of the initial five items appeared in all of the included Algebra I courses. However, in the process of identifying lessons we found two topics— quadratic equations and linear equations—that each of the providers did address. While neither of these topics was precisely equivalent to any of the CCSS items, they did reflect instances of substantive learning content that was common across the providers and that was addressed in a single lesson within each course—which was our original focus. Thus, for each provider, we used the lessons on these two topics to complete the lesson-level section of the Courseware Review.

We piloted the courseware coding method using one state provider and one private provider. We assigned two researchers to code both the overall course-wide characteristics and the lesson characteristics for one specified lesson (i.e., the lesson where students derive or use the quadratic formula). The researchers both independently coded the course/lesson and then met to discuss findings, determine reliability, and adjust the coding scheme as necessary. Overall, the agreement meetings revealed that the researchers shared a common understanding of both the coding scheme itself and what they were seeing within the provider courseware. Specifically, coder reliability averaged 85% for the course-wide coding section, and 88% for the lesson-level section. For the remainder of the coding, we assigned a primary reviewer to each provider, who coded both the course-wide characteristics and two specified lessons. A secondary reviewer assigned to each provider conducted a "spot-check" of the primary reviewer's coding, and then the two coders met to resolve any differences. We selected a specific subset of codes to use for spot-checking that included codes that tended to spur debate during the pilot process and codes that were particularly critical for understanding the courseware.

Reading Level

As described previously, the courseware review protocol is designed to capture information about the design and structure of the providers' Algebra I course materials. To supplement this protocol and examine content and style, we measured the reading level of the two target lessons using a popular readability formula. Such formulas quantify the level of the words and sentences in text, which are the first causes of reading difficulty (DuBay 2004). Nearly all government agencies apply readability tests to public documents, as do the majority of textbook publishers, who use a readability index to evaluate whether textbooks are grade-appropriate (DuBay 2004).

There are various models of readability, but all attempt to "provide an objective prediction of text difficulty" by measuring grammar, syntax, organization, and word distribution, variety, and length (DuBay, 2004, p. 54). The prediction is often expressed as a grade level, meaning that most individuals with a given level of educational attainment would understand the text. Various readability measures use different definitions of grade level, but all provide internally consistent and objective measures of readability. One of the most widely used and validated readability tests is the Flesch-Kincaid reading level test. It is based on research indicating that shorter sentences and words correlate with reading comprehension, and it is used by the U.S. Department of Defense, Internal Revenue Service, and Social Security Administration to measure readability of official documents (DuBay, 2004).

The Flesch-Kincaid formula determines readability by measuring the average word length per sentence and the average syllables per word, and adjusts these with constants to translate the result to a grade-level scale. The formula is as follows:

.39 × (total words ÷ total sentences) + 11.8 (total syllables ÷ total words) − 15.59 = Grade Level

While the Flesch-Kincaid formula offers an objective benchmark of readability, it does not offer a holistic view of a course's readability. When students read text in online courses, other factors come into play that influence their ease of reading, such as design (e.g., typography, format, illustrations) and structure (e.g., chapters, headings, navigation). Further, the formula does not reflect the difficulty level of text content, such as maturity or complexity of the math content itself.

An online math class offers particular challenges for assessing readability. One important factor to consider is the quantity of text that students see on the screen at any given time—and specifically, how much text students are willing to read before they abandon the task at hand. These considerations have added nuance in math, which uses a relatively small, but highly specialized vocabulary with big words, precise semantics, and many symbols. However, we have not found any literature that identifies how much text students are in fact willing to read on a page (or screen, in the case of online courses) before they give up on the reading task. At the same time, we know that authors of math textbooks and online math content do not expect students to read everything. Instead, some content is "essential," while other content provides additional but nonessential context or depth.

Essential text may include, for example, problem statements, definitions, equations, instructions, or post-hoc explanations in the main navigation path that students are expected to read. Nonessential content is defined as content that may be in optional navigation paths (e.g., optional pop-ups, optional hyperlinked text), or content that provides additional but nonessential context or depth. It excludes multimedia elements (e.g., video tutorials, audio clips, graphics, animations) and text that may be embedded in multimedia (e.g., closed captioning for video tutorials, text in an image file). In order to understand how much material students must actually read, our team first identified "essential" and "nonessential" text within target lessons, and then calculated the quantity of essential reading content by applying the Flesch-Kincaid test.

Errata

The following are changes made in September 2013.

Edgenuity Profile

Page 65	Circles in the Assessment Table were modified as follows: Multiple-choice was changed from Present (half shaded) to Dominant (fully shaded), Free-response was changed from Dominant (fully shaded) to Present (half shaded).

Florida Virtual School™ Profile

Page 70 and 71	Circle in the Driving Standard Table was modified as followed: Traditional (e.g., NCTM) was changed from Absent/Minimally Present (white circle) to Present (half shaded).

BILL & MELINDA
GATES *foundation*