Research Base and Instructional Design of Edmentum Digital Curriculum

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Instruction: Online Learning in the Twenty-First Century

The digital revolution of the past three decades has dramatically expanded the options for integrating technology in schools and classrooms. That is especially true for online learning. The sophistication of educational tools and the ways to render on-screen content in rich formats not imagined before have grown exponentially. Many products have come and gone to meet the needs of digital learning. But among today's many product and service offerings, one company is particularly well situated to lead the digital revolution in education in the twenty-first century. That company is Edmentum.

Edmentum holds a special place in online learning. The name is relatively new, but the company formed in the early 1960s, long before computers could be found in every home, kitchen, pocket, and purse. Under the name PLATO, the company created what most experts agree was the first authentic computer-assisted learning system designed for widespread use. This system was built at the University of Illinois at Urbana-Champaign.

That first digital learning system was a milestone, not only because it was computer-based but also because learning scientists designed it. PLATO embodied revolutionary instructional principles that incorporated leading insights in education and psychology. It featured graphics and animation, something textbooks couldn’t imitate. It created affordances for social learning with teacher-student interaction, a rigorous curriculum, sound assessments, and personalized learning strategies to increase student motivation and achievement. This innovative product could not have been developed without the involvement and commitment of educators. It was more than an engineering feat, though it was that too.

Today, the PLATO system is known as Edmentum Courseware. What hasn’t changed over more than 50 years is that educators’ needs and student outcomes are first and foremost in Edmentum’s strategic intents. Edmentum’s use of world-class instructional methodology and architecture goes back to that great innovation in 1960. Over the years, educational psychologists, learning scientists, researchers, and philosophers of education have continued to build on the principles of learning theory, which are rigorously applied to Edmentum Courseware.

It was once thought that online learning should be contrasted with classroom learning. Today, that is no longer the case. Students can now move seamlessly between online learning and classroom learning. Many teachers, in fact, have come to rely on online learning to aid in all levels of instruction, whether capturing and analyzing real-time student performance data or delivering individualized content in a blended classroom.

Some might wonder if online learning will one day replace traditional learning. We at Edmentum don’t think so. We maintain that teaching will always be a practical and creative activity, based upon both the characteristics of students and the professional judgment of teachers and
administrators. But we also maintain that online courseware will always be a valuable option to incorporate into the educator’s creative mix.

This paper is an invitation to learn about Edmentum Courseware and how it helps teachers and students achieve learning outcomes.

**Who Are Today’s Learners?**

The Millennial generation is moving through colleges and into careers. They are teachers, principals, and superintendents. A new generation, Generation Z, is working its way through K–12, with Generation Alpha right behind them.

A recent book by University of Arizona researchers Corey Seemiller and Meghan Grace (2016), *Generation Z Goes to College*, seeks to prepare educators for these new learners. The authors are educational researchers with expertise in competency-based testing and instructional design. Their study is based on a national survey of more than 1,100 students born after 1995. Their measurements included not only demographic questions but in-depth measures of relationship styles, learning styles, communication methods, social media use, social concerns, politics, optimism, and spirituality. This research study is particularly comprehensive, designed with a rigor that urges us to look carefully at the results.

The overarching principle is this: Whereas Millennials were tech savvy, members of the new generations can be characterized as tech integrated. Because they are immersed early and often in technology—cell phones, tablets, and smart devices such as Google Home, Alexa, and the Internet of Things—they tend to experience technology not just as a game platform or a form of distraction; rather, they expect technology to make their lives work. They assimilate objects as technological in nature even if they aren’t sure how they are used. For example, kindergartners are frequently confused by a desktop computer with a mouse. They’ve been known to point the mouse toward the computer screen like the more familiar television remote control. These subtle differences influence their implicit knowledge of how things work.

The touch screen is an apt metaphor for Generation Z. Technology is personal to them, it is an extension of the self. This is true to a lesser extent of some adults, who sometimes touch their desktop screens at work, forgetting that many work screens are not touch screens.

Here is some of what the researchers discovered about how online courseware might uniquely meet the needs of Generation Z and the generations that follow:

**Hands-on learning.** This generation’s work style tends to be hands-on. Courseware, of course, is built to be interactive, where students use tools—interactive historical timelines, mathematical function explorers, maps, and more—to explore concepts in concrete ways that are difficult to create in traditional classrooms.

**Working independently.** Generation Z prefers independent work. Courseware allows students to work irrespective of platform and physical location, perhaps more so than any other learning
mode. This approach doesn’t preclude lessons where students work collaboratively in groups, engage in discussion, and give feedback. But the modality of online learning is uniquely suited to independent work not bound by location, space, and time.

**Working at their own pace.** This generation prefers self-directed work. Teachers do what is practically possible to help students work at their own pace. But courseware may be more individualized than other instruction modes because there is more leeway for self-pacing. Courses are customizable to fit the learner’s individual needs.

**Working solo.** Unlike students in previous generations who favored working in groups, Generation Z prefers working solo. Courseware is an intimate, one-to-one encounter of the student with the course material. Perhaps students gain a greater sense of accomplishment by working through material alone successfully. Or perhaps students get lost in a group setting and feel that their individual ability and talent doesn’t stand out. In any event, one of the factors that Duckworth (2016) identified as an essential aspect of deliberate practice in the behaviorist learning model was practicing alone, as opposed to in groups.

**Practical interactive learning exercises.** This generation tends to view teachers as facilitators of learning and prefers not to be “lectured at.”

This brief introduction to the new generations has only hinted at some major themes, but online learning is in many ways tailor-made for these generations. What instructional principles and instructional design architecture make sense for the new generation of online learners? And how does Edmentum Courseware meet the high expectations of the new age?

**Edmentum’s Instructional Design Principles**

The research base of best practices in education is ever-growing, and innovative approaches are constantly being tested. The role of research and theory in educational science is to give administrators and teachers reasons why they prescribe the interventions they do. A good rationale can draw from applied research as well as theory. Certain enduring theories and compelling research explain why Edmentum Courseware is an effective and useful part of an educator’s professional landscape.

Harasim (2017) warns that “a common tendency of educators has been to merely integrate technology into traditional ways of teaching” (p. 2). For example, teachers incorporate email, wikis, blogs, and Google docs into traditional teaching in hopes of finding how these resources fit. It’s somewhat of a trial-and-error process. At Edmentum, we believe it is worthwhile to first take a step back and distill the principles that have traditionally come to inform sound educational practice into a handful of solid foundations that form the bedrock of Edmentum’s methodology.
In designing Edmentum Courseware, instructional designers think in terms of seven partially overlapping yet distinct principles of effective instruction, each of which has a sound basis in theory and research:

**Constructivist Learning**

A cornerstone of Edmentum Courseware is the principle of constructivist learning, a dynamic interaction between the learner and the subject matter. Constructivist learning theory posits that learners must be active participants in the process of constructing their own knowledge. Learners need more than knowledge presentations, regardless of whether those presentations are written, spoken, demonstrated, or presented through video or multimedia.

In the constructivist model, students conceptualize things using what Piaget and other cognitive psychologists call schemas. A schema is one’s current way of thinking about a thing. On a basic level, humans learn by observing their world, forming informal rules about how things work (schema), and adapting those schemas if later experience displays flaws or limits.

We humans employ this basic experiential learning process constantly. It’s supplemented and greatly enriched by the socially transmitted knowledge that we receive through discussion, presentation, the written word, and other media. As a result, education is most effective if it combines the experience and experiment of constructivist learning with the various sources and modes of social transmission.

Constructivist learning has value in every subject domain. We can learn the skills of effective writing, for instance, by doing a lot of writing, getting feedback from others (social transmission), detecting patterns in what seems effective in our writing, and refining our approach to get consistently good results.
Making observations, analyzing and detecting patterns, making hypotheses, and testing and refining those hypotheses is the constructivist process at the center of science and mathematics. Professional scientists practice science inquiry all the time. Inquiry is such a strong strand in modern science and math education because it is a basic human learning process and a core practice of the discipline.

In Edmentum Courseware lessons, students begin by answering one or more warm-up questions in which they think about and record their perception of how something works. Later in the lesson, students might review their initial response to a warm-up question and comment on it. This kind of self-reflection (and metacognition) is a powerful element of constructivist learning.

For example, in Edmentum’s geometry course, students play with a simple online interactive triangle, moving each vertex around at random and then stopping and recording the measures of the three internal angles. After several trial results, do they see a pattern? Can they make any triangle that breaks that pattern? The angles always add up to 180 degrees, no matter how hard they try to break the rule. Students are then challenged to construct a proof for this rule. In the end, this activity—with its detective-like challenge—is more powerful educationally than being told the simple rule and then being asked to construct a formal proof.

Beyond developing new rules, students can refine and extend their understanding through experiment. In Edmentum’s Algebra 1 course, for example, students are challenged in the warm-up to solve a graphing problem by plotting a quadratic equation point by point (figure 1). Later, they use an online graphing tool to manipulate parameters of three different forms of the quadratic equation. Through this scaffolded activity, students come to understand the graph “rules” for each equation form. They also come to see the value of having these different equation forms as instruments in their math toolbox for powerful problem solving.
The graphing tool found in Edmentum math courses takes advantage of a less-developed schema, the idea that a figure can be graphed by connecting points. This existing skill provides the stepping-off point from which a student will encounter a curve as a smooth line connecting many points. In the graphing tool, the student uses line segments from point to point as preparation to grasp the important insight that points can determine not only lines but also complex functions.

Student agency. A closely related learning variable is the idea of student agency. In a nutshell, “the implication [of student agency] is that the most transformative learning experiences will be those that are directed by the learner’s own endeavors and curiosities” (Lindgren & McDaniel, 2012, p. 2). Learning depends on the student deciding to do something intentionally to control and influence the learning environment.

Creating a learning environment that incorporates student agency is believed to enhance outcomes in two ways. First, because choosing to act in a personal way introduces a strong motivational component, people are more motivated to achieve goals they set for themselves. Second, engagement in a lesson where there is student agency, with the student setting the terms of interaction, is said to increase student self-efficacy. The latter has been shown to be decisive in achieving mastery of learning competencies. Finally, when students act as agents in
their own learning, it’s easier for them to incorporate existing knowledge into new learning situations, a concept at the core of constructivist learning (Lindgren & McDaniel, 2012).

Skills Mastery Focus

To some, behaviorist learning theories are an artifact of history. Aren’t they incomplete because they focus only on observable outcomes, neglecting the mental aspects of learning? On the contrary, the behaviorist model is as valued today in educational research as it ever was. The reason we don’t think of behaviorism as an influence on sound instructional design is that we have become so accustomed to it that we hardly notice how prevalent its influence has been. Indeed, behaviorist learning theory provides the underpinnings of Edmentum’s focus on skills mastery.

Break units into well-defined skills. The first rule of skills mastery focus is to decompose units into bite-sized components before conveying them to learners. Similarly, when constructing assessments, we decompose outcomes into groups of items defined by a skills blueprint to show how well learners mastered the skills that compose the unit.

Progression of learning. Skills defined by decomposition can span a larger domain of knowledge. Many educators organize skills into learning paths. A learning path is an informed ordering of educational content that ensures skills are encountered in a natural order, either cognitively by aligning with a student’s level of cognitive development, or logically, by taking into account the prerequisite skills found in other course content. Edmentum constructs its courses using both cognitive and logical learning progressions.

Mastery. Behaviorist learning theory created what is now known as the mastery learning criterion of knowledge. Begun by Bloom in the 1960s, the idea of mastery is that every child, if given enough time, can learn well-defined skills to the level of mastery. A well-designed curriculum should have opportunities for knowledge checks along the progression to mastery.

Edmentum’s courses are designed in units, each of which contains multiple lessons. Individual lessons are skills based. Each lesson has tutorials and activities that students can work on at their own pace. After completing a lesson, students take a mastery test. Based on the scoring system, an 80% mastery rate signals that the student is ready to move on to a new lesson. The scoring system can also accommodate custom cases where a 70% or 65% threshold is desired.
The notion of operationally defined objectives and clearly articulated modules is so familiar today that we hardly recognize the innovation. It is expected of a well-designed instruction module. In the syllabus for the first semester of Edmentum's 8th grade English course (figure 2), notice how the material is organized in constituent components with explicit objectives in italics. Notice also that the learning unit culminates in a posttest.

**Practice**

Behaviorist learning theory applies not only to the presentation of material but also to the effect of practice on skill acquisition and retention. The learning curve, a familiar concept, is a uniquely behaviorist legacy. It emphasizes the link between practice, reinforcement, and performance.
**Warm-Up.** Preparation is an important principle of practice. Edmentum courses feature warm-up activities in many lessons. Figure 3, for example, is a warm-up exercise in a lesson on potential energy from Edmentum’s Middle School Science curriculum.

| Warm-Up |
|---------|---|
| Type your response in the box. Imagine a girl climbing a rope ladder to ride a zip line. It takes effort for her to get to the top of the ladder, but then she zips to the ground with ease. She travels down easily because she has stored energy. What’s your guess about where this energy came from? |
| There's stored energy since the girl climbed to the top of the rope ladder. She put energy in to reach a higher position. |

*Figure 3 Sample warm-up activity*

**Real-World Applications**

Assignments and activities impel students to apply what they know to the real world. Depending on limitations and available resources in the school or home, students might perform hands-on science experiments. Interactive online tools, such as PhET simulations, also allow students to gather data to analyze simulated situations, parameters, and behaviors.

Edmentum incorporates real-world applications in both learning investigations and content presentation. Figure 4 shows how the concept of kinetic energy is introduced in Middle School Physical Science. Note that the illustrations present kinetic energy in ways that students can relate to their everyday experiences.
Rigor, Relevance, and Complexity

The cognitive model broadens and augments the behaviorist model by attending not only to the surface features of content and assessment but also to the deep structures in cognition that influence how lessons are conceptualized by learners. Here, we focus on specific aspects of cognitive psychology from the field of educational psychology. The cognitive model emphasizes the role of memory and cognitive depth. For example, educational psychology has recently paid a great deal of attention to the ways in which working memory assists the learning process, how cognitive load might impede the learning process, how children acquire and modify conceptual representations, and how cognitive schema account for developmental differences in child development.

Cognitive psychology. Educational psychologists recognize cognition as an integrated process that uses a wide range of independent modular systems. There is not one memory system, but rather several. There is not one system of reason, but rather several distinct cognitive acts. There is not one memory system, but rather several, including declarative memory, nondeclarative memory, and autobiographical memory. There is not one system of reason, but rather several distinct cognitive acts, such as language processing and syllogistic logic.

Rigor/Relevance Framework. Dr. Bill Daggett created the Rigor/Relevance Framework, which places learning and student achievement in two dimensions. Rigor is the level of knowledge defined by the classical taxonomies of Bloom and Anderson-Krathwohl. The second dimension, relevance, is the ability to apply concepts or skills to solve real-world problems. Relevance comprises a five-level continuum.
As described by Daggett (2016):

The Rigor/Relevance Framework has four quadrants.

**Quadrant A** represents simple recall and basic understanding of knowledge for its own sake. Examples of Quadrant A knowledge are knowing that the world is round and that Shakespeare wrote *Hamlet*.

**Quadrant C** embraces higher levels of knowledge, such as knowing how the US political system works and analyzing the benefits and challenges of the cultural diversity of this nation versus other nations.

**Quadrants B and D** represent action or high degrees of application. Quadrant B would include knowing how to use math skills to make purchases and count change. The ability to access information in wide-area network systems and the ability to gather knowledge from a variety of sources to solve a complex problem in the workplace are types of Quadrant D knowledge.
Each of these four quadrants can also be labeled with a term that characterizes the learning or student performance.

Daggett’s model demonstrates the application of knowledge or skills from the lowest level of knowledge within one discipline to the highest level, where knowledge is applied to real-world, unpredictable situations. For example, in the area of technical reading and writing, the continuum might look like this (Daggett, 2016):

- **Quadrant A**: Recall definitions of various technical terms.
- **Quadrant B**: Follow written directions to install new software on a computer.
- **Quadrant C**: Compare and contrast several technical documents to evaluate purpose, audience, and clarity.
- **Quadrant D**: Write procedures for installing and trouble-shooting new software.

**Webb’s Depth of Knowledge.** Norman Webb, PhD, from the Wisconsin Center for Education Research at the University of Wisconsin–Madison, created a framework for a cognitivist emphasis in education (1997). He has influenced many educators to strengthen the alignment of their curricula and their assessments by attending to what is now widely recognized as Depth of Knowledge (DOK), or the levels of content complexity.

Edmentum has an ongoing partnership with Dr. Webb. Curriculum developers and subject matter experts who work at Edmentum are trained in Dr. Webb’s DOK model.

**Multimodal Learning**

Moreno and Mayer (2007) wrote a paper outlining the empirically supported principles of “learning with media,” describing the aspects of digital-learning environments that provide the affordances that make learning possible.

**Parallel processing.** Moreno and Mayer teach that multimodal environments offer affordances for learning because human cognition uses digital and analog representations simultaneously to process information. This concept was first introduced by psychologist Allan Paivio, whom the authors recognize as an innovative and influential cognitive psychologist of the twentieth century. Paivio taught that “dual processing” (later referred to as “parallel processing”)—the mind representing objects in multiple modalities—is prevalent in human cognition.

This concept is more than common sense. It is a deep and subtle psychological principle. One could describe a flower digitally (logically) using language: “The stem is below the sepal, which is below the petal.” An analog (pictorial) description of a flower is a redundant, dual representation naturally found in human cognition, and it reinforces the digital description. The analog representation is separately constructed and encoded by the human brain.
Multimodal learning environments capitalize on human cognitive architecture. Coordinating multiple representations of a concept facilitates more enduring learning foundations. A concrete example of representation at the analog and digital levels can be found in Edmentum’s natural science courseware. In this Course Activity, the student researches and identifies the reproductive parts of a flower (figure 6).

**Question**

Research the different parts of a flower. Be sure to use credible sources. Label the parts in the image below.

![Figure 6 Example of multimodal learning](image)

Cognition works more efficiently when such separate, redundant processes interact. A multimodal learning environment uses more than one representation to mutually support the other representations in the lesson.

Multimodal learning methods are used everywhere in Edmentum courseware. First, there are the interactive instructional objects themselves, embedded in learning modules. Examples include the following:

**Click-to-See.** Students click hotspots in images to access detailed information about a topic. Instructional uses are as varied as identifying the stages in a cell cycle and analyzing a poem.

**Step-by-Step.** In step-by-step interactions, students click thumbnail images to display detailed information. Students can explore a process or procedure or examine a set of people or milestones. In an Algebra 1 lesson, for example, a step-by-step allows students to compare the
procedures for calculating average rate of change for a function presented as an equation, a table, and a graph.

Maps. Interactive maps allow students to explore locations, present-day or historical.

Timelines. In some Edmentum lessons, a powerful and natural implementation of real-time interactivity occurs in the use of timelines. Figures 7 and 8 come from a learning module on the history of US foreign policy. The student can click anywhere in the timeline to scroll forward or backward. Clicking the specific dates indicated displays additional material in a multimedia format. The sequence of linear knowledge acquisition is augmented by the ability to travel and explore time itself.

![Timeline Screenshot](image)

**Figure 7 Sample timeline interaction**

![Timeline Screenshot](image)

**Figure 8 Detail from sample timeline interaction**

Multimodal learning methods are also enhanced by the tools featured in the learning platform itself. Embedded learning tools available to students in Edmentum courseware include the following:
Text to speech. Students can request text to be read by a human voice using a text-to-speech tool.

Translation. English language learners may request words to be translated using their native dictionary.

Video clips. Students can explore lesson topics by playing video clips.

Highlighters. Students can use a text highlighting tool to highlight important points as they read.

There is strong empirical evidence for the multimodal affordances described by Moreno and Mayer (2012). The scientific evidence for these and other affordances of technology-enhanced constructive learning has been comprehensively reviewed by Semerci and Batdi (2015), Li and Ma (2010), and Rosen and Salomon (2007). Hundreds of quantitative scientific studies have indicated that there is a quantifiable positive effect of constructivist, multimodal, online instruction for all age levels.

Passion, Perseverance, and Grit

There is a new emphasis in learning science. Human ability was once seen as largely a result of inherited aptitude, but learning scientists and cognitive psychologists today are far more likely to emphasize the personal characteristics of the learner. Skills mastery leading to expert performance is as much a product of how students practice as of how intelligent they are.

Achievement to a limited extent depends on preexisting ability, or aptitude. But it depends much more on the perseverance of students in practicing the lessons they are given. And it depends on how well the teacher captures the motivation and passion that students have for the subject matter.

In Grit: The Power of Passion and Perseverance (2016), influential cognitive scientist Angela Duckworth compiles insights from her own research and that of other eminent psychologists, educators, and experts in a variety of fields. She notes that all children want to learn, and all have the cognitive capacity to master the primary and secondary school curriculum. It’s not a question of some students being talented and others not:

I began to reflect on how smart even my weakest students sounded when they talked about things that genuinely interested them. These were conversations I found almost impossible to follow: discourses on basketball statistics, the lyrics to songs they really liked, and complicated plotlines about who was no longer speaking to whom and why. When I got to know my students better, I discovered that all of them had mastered any number of complicated ideas in their very complicated daily lives. Honestly, was getting x all by itself in an algebraic equation all that harder? (p. 17).
What students need is a lesson that presents the material in a compelling way and invites them to challenge themselves with learning exercises that lead them to practice for prolonged time periods.

A good learning platform must not neglect the value of breaking lessons and assessments down into components, presenting learning stimuli in salient and compelling ways, and providing intensive opportunities for rigorous, self-directed practice in a way that challenges students to strive above their current level of proficiency.

It is also worthwhile to connect these concepts to the idea of student agency (discussed above in relation to constructivist learning). In particular, a learning environment that elicits student agency necessarily strengthens the student’s personal engagement, and therefore is a motivating factor. The concept of grit subsumes and presupposes that learning must be a product of passion. An engaged, focused student who desires a positive outcome has one of the necessary conditions for grit.

Edmentum’s Algebra courses, for example, were designed by subject matter experts with precisely this passionate, self-directed practice in mind. In fact, during curriculum design interviews, these specialists said what they heard loud and clear from teachers was “practice, practice, practice.” Algebra courses feature student driven on-demand practice by lesson, unit, and semester. These features of the Algebra courses are in line with what researchers encourage with the notion of passion, perseverance, and grit. It is not enough to practice. The student must choose which areas require intensive practice. This is deliberate practice.

**Edmentum’s Instructional Architecture**

Edmentum’s curriculum begins with the people who write it. The curriculum and assessment writers are first and foremost educators. Many are teachers or have wide-ranging experience in education. Edmentum’s subject matter experts have at least a master’s degree in their area of specialty. These experts are instrumental in course design.

Edmentum’s project teams are supervised by individuals with many years of experience and a great deal of practical wisdom. One way that the real-life connection to education comes through is that every new course begins with Edmentum staff personally visiting and meeting with teachers. We ask teachers what is most important to them and use their feedback to make each course better than the last.

Figure 9 shows the logical structure of a course, a unit, and a lesson. These components are defined in detail below.
Course Structure

- Courses are founded on a scope and sequence that comprehensively addresses national and state standards.
- A course includes a student orientation, a course syllabus, and one or more units.
- A unit typically includes a pretest, online discussion, one or more lessons, practice, unit activities, and a unit posttest.

Unit Structure

Unit pretests determine previous knowledge and give students a chance to be exempted from certain units based on mastery of previous knowledge (see Assessments).

Learning modules provide specific instruction (see Learning Module Structure).

Unit discussions allow teacher-to-student and student-to-student discussion and debate about topics covered in the unit. These discussions require students to synthesize knowledge acquired during lesson mastery and apply critical-thinking skills to answer questions, form opinions, express ideas, and respond to the ideas and opinions of others.
Unit activities offer students the chance to demonstrate higher levels of skill by completing a rich task and submitting the resulting project, paper, essay, data, research, or presentation to the teacher via an online digital drop box.

Unit posttests assess topic-level mastery at the end of each unit (see Assessments).

Learning Module Structure

Individual learning modules are designed to reflect the specific type of knowledge or skill addressed within the lesson (e.g., procedural knowledge or declarative knowledge). Lesson design elements include the following:

- **Tutorials** are designed to help learners acquire and build knowledge:
  - Tutorials include a variety of interactive practice activities, such as exploratory timelines and clickable diagrams. Judged activities include multiple-choice, matching, fill-in-the-blank, drag-and-drop, and multistep problem-solving questions. Other learning resources include embedded videos and links to valuable educational resources.
  - Some tutorials are specifically designed to help learners research, build, and deepen their knowledge.

- **Other activities** are added to a learning module to meet specific learning needs:
  - Lesson activities are similar to the unit activities described above, but they are focused on lesson-level objectives.
  - Application activities allow learners to apply knowledge to new situations and real-world problems.

- **Practice.** Learning modules may have repeated opportunities for practicing the concepts and skills introduced in tutorials. This is particularly the case for Algebra, where students can define the skills they want to focus on.

- **Mastery tests** conclude each module (see Assessments).

Assessments

Each Edmentum Courseware product includes multiple assessments designed to continually check understanding, measure mastery, ensure knowledge retention, and predict preparedness for course exams. The assessments include these tests:

- **Mastery tests** measure whether students have mastered lesson objectives and are prepared to move on to the next learning module in the instruction.

- **Unit pretests** measure students’ knowledge of the unit learning objectives before beginning the lesson instruction and allow students to test out of lessons by demonstrating mastery. Unit pretests are most often used when an accelerated timeline is needed, such as in credit recovery.
• **Unit posttests** measure students' understanding of both the basic knowledge and the higher-level skills within each unit. These assessments help ensure that students are building and retaining knowledge from lesson to lesson throughout the unit.

• **Course and unit activities.** Performance and project-based assessments are also supported. The teacher can assign these teacher-evaluated activities, allowing for more qualitative evaluation that can be customized to the student.

• **End-of-semester tests** measure students’ mastery and retention of the instruction in every lesson and unit in the semester.

Edmentum’s assessment items are of the highest quality. Edmentum has benefitted from a close partnership with Dr. Norman Webb from the Center for Educational Research at the University of Wisconsin–Madison. Subject matter experts and item writers are immersed in Webb’s DOK framework. Edmentum’s content developers are urged to use technology-enhanced items in all tests, which often reflect higher DOK complexity. Edmentum continues to deepen its item banks with psychometrically valid items across the full range of DOK.

<table>
<thead>
<tr>
<th>Level</th>
<th>Cognitive Aspects</th>
<th>Activities and Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOK Level 1</td>
<td>recall and reproduction</td>
<td>simple formulas, definitions, one-step activities requiring surface-level understanding</td>
</tr>
<tr>
<td>DOK Level 2</td>
<td>skills and concepts</td>
<td>using information, applying knowledge, deciding, choosing an appropriate procedure, making an inference; classify, compare, contrast</td>
</tr>
<tr>
<td>DOK Level 3</td>
<td>strategic thinking</td>
<td>forming an action plan, a sequence of steps, abstract, non-routine reasoning; use of evidence; use of a skill in a new way, hypothesize, develop an argument</td>
</tr>
<tr>
<td>DOK Level 4</td>
<td>extended thinking</td>
<td>extended use of higher order thinking skills; synthesis, reflection, complex restructuring of data; design, propose, solve</td>
</tr>
</tbody>
</table>

*Figure 10 Webb’s DOK framework*

**A Formal Methodology**

The development of each course includes an instructional designer, subject matter expert, writer, and media specialist whose sole focus is developing world-class evidence-based curriculum, instruction, and assessment. Every Edmentum course begins with a course design document. Preceding the development of this document, Edmentum staff completes extensive research in collaboration with educators. Research methodology includes analysis of educator feedback on existing curriculum, instruction, and assessment; conversations with Edmentum Services and
Support Team members who work every day directly with educators who use Edmentum courseware; surveys administered to educators who are subject matter experts teaching in classrooms across the nation; focus groups in multiple cities facilitated by educational leaders; interviews; and more. After the research is complete and the guidance document has been written, educators continue to participate as partner-consultants in actual course development.

National and state standards are always reviewed at the beginning of a course design. Edmentum subject matter experts are highly skilled at aligning standards and skills to specific lessons and assessments.

After the research is complete and the guidance document has been written, educators continue to participate as partner-consultants in actual course development. National and state standards are always reviewed at the beginning of a course design. Edmentum subject matter experts are highly skilled at aligning standards and skills to specific lessons and assessments.

After the course design document is finished, course development begins. Courses are built to be a semester long but may be customized for other schedules such as summer sessions or trimesters. Developers start with a curriculum structure built around discreet learning objectives. Then, each learning module, or lesson, is focused on one individual objective. Each module includes an introduction to the new material, a chance to practice or apply new knowledge, and an opportunity to demonstrate mastery of the objective before progressing to the next module. This structure is built into units of related material and includes pretests to assess prior knowledge as well as posttests and end-of-semester tests to confirm mastery for broader levels of content beyond the lesson.

Benefits of the Course Design

Each course is designed to ensure the following benefits to teachers and learners:

**Self-paced learning that supports multiple learning modalities.** Individual differences, learning styles, and multiple intelligence are all part of the movement toward individualized learning. Edmentum courseware always supports the ability of students to advance at their own pace using multiple learning modalities.

**Dynamic, interactive, digital content that engages students.** Learning is best when students are engaged. Founded in constructivist principles, Edmentum’s courseware always engages the student to interact with lessons.

**Modules easily customized by teachers to meet local standards and pacing guides.** For teachers, one-size does not fit all. Different localities have their own standards and pacing guides. Sometimes it’s not practical to encourage self-pacing. Some teachers might want to add lessons or practice sessions. Lessons are always customizable and can be made to fit a teacher’s goals and objectives.

**A rigorous alternative to traditional classroom courses.** Edmentum courseware has always emphasized the rigor and relevance of course materials. These elements are part and parcel of the mastery learning approach and of the emphasis on passion and persistence described earlier. Edmentum challenges students with rigorous instruction and practice in ways that are relevant.
Flexible assessments. Edmentum is very good at assessments. Teachers need to know that Edmentum assesses aptitude and achievement in many different ways. Pretests are diagnostic tests that help determine how well prepared the student is. In many cases, because of the quality of pretests, Edmentum can accurately judge whether a particular student can profitably skip a course. The posttest confirms how well the student has mastered the material. Finally, a variety of teacher-graded activities and assignments provide more subjective indicators of student progress. This full range of assessment techniques makes Edmentum’s assessments useful, accurate, and flexible.

Many Roles of Online Learning

First-Time Credit
One role that courseware may play in a school is first-time credit. Students who are most likely to use courseware in this way are confident in their ability to learn, comfortable with technology, and curious, with an aptitude for exploration. Online learning has come to the mainstream, and many students prefer to learn online.

Credit Recovery
Online courseware plays a critical role in credit recovery. A student might have attempted to take a course in the classroom but failed it for many possible reasons. Perhaps the student became ill in mid-semester or had a problem with motivation. Courseware can be used to adapt a particular course to those areas a student needs to make up. The teacher can customize the course structure to the individual, prescribing only those lessons the student needs. This use of courseware can make the difference between a student being able to graduate or not.

Course Expansion
Courseware can fill a role that might not otherwise be available. Perhaps a small district has a shortage of qualified science teachers. Or maybe some students are motivated to learn a foreign language not currently provided in the school system. Edmentum offers more than 300 courses, allowing schools to radically extend their course offerings in ways not otherwise possible.

Career and Technical Education. A specific use case for course expansion is careers and technical education (CTE). CTE courses allow students to explore the world of work outside of academic disciplines. Students can learn about a range of vocational and technical careers in fields such as computer programming, health care, and manufacturing.

STEM. Students who are pursuing careers in the sciences, engineering, and mathematics will benefit from STEM courses. These students have the opportunity to build a transcript of courses to make themselves competitive in college applications.

Advanced Placement. Advanced Placement (AP) courses allow students in some districts to qualify to receive college credit for advanced courses such as statistics.
None of the roles described here exhaust the ways in which courseware may be used by creative educators. For example, a teacher might use an AP course, but not necessarily to fulfill college credit. The teacher might select specific units and lessons to challenge a good student who may or may not be college bound.

Courseware facilitates freedom in the way that lessons are prescribed. This is a gift to both the student and the teacher.

**Conclusion**

Education moves in cycles. It sometimes appears that ideas come, go, and return. But there is also a forward trajectory in which methods and tools improve. It is important to differentiate between short-lived cycles and enduring trends in education.

The best ideas in education will never die. They include the importance of the teacher, the value of persistence, the need to engage the full range of human cognition, and, most of all, the importance of active construction of knowledge through social interaction.

There is no one-size-fits-all instructional design. Nevertheless, we at Edmentum have created a powerful synthesis of design and technology.

When the world went fully digital in the twenty-first century, some wondered whether that would change everything. Yes and no. The internet, connectivity, rich media, and instant communication have flipped some traditional notions of teaching and learning. But the core principles of teaching and learning are in many ways unchanged.

Edmentum has had the vision, for more than 50 years, to see the promise of digital online learning. What sets Edmentum apart is that it has brought the excellence and the very best of behaviorist, cognitivist, and constructivist instructional design to these modern platforms. That is what makes Edmentum Courseware superb.
References


Appendix: ESSA Evidence

Edmentum’s Evidence-Based Products

Founded in innovation, Edmentum is committed to being educators’ most trusted partner in creating successful student outcomes everywhere learning occurs. Part of this mission is a commitment to research. Edmentum was originally funded through a National Science Foundation, Institute of Education Sciences grant in 1960 and has been innovating ever since. Edmentum’s research team includes psychometricians and education research specialists whose sole focus is developing world-class, evidence-based curriculum, instruction, and assessment. The research team’s purpose is to conduct valid and reliable research that is meaningful, improves teaching and learning, and supports the development of fair and equitable learning environments. Evidence of effectiveness is at the center of what Edmentum’s research team does.

The term evidence-based addresses activities, strategies, and interventions used in an educational setting. The US Department of Education (2016) provides non-regulatory guidance advising that to show evidence, one of two conditions must exist: 1) The evidence base must demonstrate a statistically significant effect on improving student outcomes or other relevant outcomes based on strong, moderate, or promising evidence, or 2) the evidence base must demonstrate a rationale based on high-quality research findings or positive evaluation (Section 8101(21)(A) of the ESEA). Evidence levels include study design, What Works Clearinghouse standards (WWC, 2014), favorable effects, other effects, and sample size and overlap. As a trusted partner in creating successful student outcomes everywhere learning occurs, Edmentum’s research team has assembled a reference that aligns Edmentum products to the US Department of Education (2016) rubric of recommended study criteria for each evidence level.

ESSA Level of Evidence

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>ESSA Definition</th>
<th>What Works Clearinghouse Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>strong evidence</td>
<td>a well-designed and well-implemented randomized controlled trial</td>
<td>meets WWC group design standards without reservations</td>
</tr>
<tr>
<td>moderate evidence</td>
<td>a well-designed and well-implemented quasi-experimental study</td>
<td>meets WWC group design standards or is the equivalent quality</td>
</tr>
<tr>
<td>promising evidence</td>
<td>a well-designed and well-implemented correlational study with statistical control for bias</td>
<td>not applicable</td>
</tr>
<tr>
<td>Evidence Supporting Edmentum Courseware</td>
<td></td>
<td></td>
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<tr>
<td>----------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>• Level of evidence: Demonstrates rationale (logic model)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Effect: Addresses the need for, development of, and implementation of CTE courseware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level of evidence: Promising evidence (correlational, quantitative)</td>
<td></td>
<td></td>
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<tr>
<td>• Effect: Found that student learning in the online environment increases when teachers are actively involved and engaged in the process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level of evidence: Demonstrates rationale (logic model)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Effect: Addresses how technology can help bring change initiatives to fruition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level of evidence: Moderate evidence (quasi-experimental)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Effect: Found that use of Courseware increased the numbers of credits recovered and decreased dropout rates</td>
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Additionally, the non-regulatory guidance provides educators with steps for continuous improvement. Continuous improvement includes 1) identifying local needs, 2) selecting relevant, evidence-based intervention, 3) planning for implementation, 4) implementing, and 5) examining and reflecting. Edmentum has a team of qualified, professional service educators who are able to provide support for continuous improvement.

- **Level of evidence**: Promising evidence (correlational, quantitative)
- **Effect**: Found that teacher engagement was the strongest predictor of higher levels of student achievement and increasing graduation rates


- **Level of evidence**: Moderate evidence (quasi-experimental)
- **Effect**: Documents the increases in student learning and achievement


- **Level of evidence**: Demonstrates rationale (logic model)
- **Effect**: Demonstrates higher graduation rates and earned credits for a rural environment school

**National Accreditation and Approvals**

- Quality Matters
- AdvancED accreditation
- ISTE Seal of Alignment

**State Evaluation and Approvals**

- Arkansas Digital Learning
- Arkansas eResources
- California A-G
- Florida Virtual Instruction Program
- Louisiana Course Choice
- Maryland State Department of Education (MSDE)
- Maine Online Learning Program
- Michigan GenNet Online Learning
- Montana Distance Learning
- North Carolina Virtual Public School
- North Dakota Center for Distance Education
- Nevada Distance Education
- Pennsylvania Department of Education
- Utah Recommended Instructional Materials
- Virginia Approved Online Provider
- Washington Online Course Approvals
- West Virginia Instructional Materials List