WHITE PAPER

Research Put into Practice:

Apex Learning Curriculum and Pedagogy

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JUNE 2017

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Introduction

Apex Learning® was founded in the late 1990s—a time when online learning was beginning to enter the popular lexicon—as one of the world's first providers of fully online, digital curriculum for secondary education. From the start, Apex Learning has paid close attention to how students learn and how digital curriculum can support that learning. Since the time of Apex Learning's founding, online digital curriculum has become widely accepted and used in secondary schools, and research has continued to show great promise for its effectiveness. However, digital curriculum is only effective when properly designed. This paper, an update to a paper originally co-authored in 2010 with Allison Moore, M.Ed., presents research pointing to the elements of curriculum design that are necessary for supporting learning in middle and high schools. Furthermore, it presents how research on learning theory has been put into practice in the development of Apex Learning digital curriculum.

Curriculum Design Is Crucial for Student Learning

While online digital curriculum has been shown in scientific studies to be effective (Cheung & Slavin, 2015; Delany, 2011; Means, Toyama, Murphy, Bakia, & Jones, 2010), its level of effectiveness is dependent on the design of the curriculum and how it is presented (Belland, Kim, & Hannafin, 2013; Guo, Kim, & Rubin, 2014; Mayer, 2008). As more schools implement online digital curriculum, it is crucial that the design of the curriculum be evaluated using evidence from the learning sciences so that young learners can reach their full potential.

This paper begins by establishing its goal: Determining what it means for a student to learn and be able to accomplish tasks and solve problems in school and in life. Then, it presents evidence on what students need in order to learn, along with examples of how Apex Learning puts this evidence into practice.

The Stakes

Students today face increased challenges of globalization and changing economic and social opportunities. To prepare secondary students for success in college or for life, curriculum must prepare them to develop expertise to accomplish complex tasks and solve complex problems. Today's more rigorous learning standards address this in part, but they do not address how curriculum needs to be designed, nor do they offer a comprehensive picture of what it means for students to learn across disciplines and apply their learning outside of and beyond secondary school. The following section summarizes what it means to learn in a way that prepares students for school and life.

How Learning Sciences Define Learning

The National Research Council's seminal book *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown, & Cocking, 2000) set one of the most widely used and respected standards for how educators and researchers define learning.

The How People Learn (HPL) framework defines successful learning as moving toward adaptive expertise—that is, the ability to apply knowledge creatively in new situations (Hatano & Inagaki, 1986). Student learners are like apprentices who work with experts (teachers and others) and tools (curriculum) in authentic settings (learning communities) to grow from novices to experts. Successful learners develop characteristics that experts possess (Bransford et al., 2000, p. 31).

- Experts have accumulated extensive content knowledge that is organized in ways that reflect a deep conceptual understanding of the subject matter in their domain.

- Experts' content knowledge is more than sets of facts and procedures; experts understand facts and procedures within the contexts and conditions for which they apply.
- Experts' deep, conditionalized knowledge enables them to notice features and meaningful patterns that novices do not notice.
- Experts can fluently access and recall pertinent knowledge with little cognitive effort.
- Experts can flexibly apply their knowledge to routine situations within their domain and may adaptively apply their expertise to unfamiliar situations, including situations outside of their domain.

Students typically begin as novices in education, with varying formal and informal content knowledge and understanding. Through the educational process, they move toward formal knowledge. Not all students become true experts in every subject, or even in one subject, but their education must develop the characteristics of expertise, even if it is to a relatively small degree compared to professionals with decades of experience.

These elements of learning do not contradict the learning outcomes specified by individual state standards. Rather, they provide evidence-based guidance on the abilities that students need to develop to meet the standards and to apply them outside of the classroom.

Apex Learning understands that the goal for students is to become active learners whose pursuit of increasingly adaptive expertise is a lifelong journey, nurtured during the secondary school years.

Learning for College, Work, and Life

Apex Learning is committed to helping students achieve the educational outcomes they need to succeed today and thrive tomorrow. These outcomes are consistent with the characteristics of experts and the goal of adaptive expertise.

Since *How People Learn* was published, the pace of globalization has increased, and young people now face significantly more competition in a global workforce. While the overall outlook for living wage jobs for people without formal education is bleak, the outlook for people with analytic and problem-solving skills is bright.

While developing academic expertise was once a privilege of the few at elite institutions, today we are tasked with empowering all learners everywhere (Davidson & Goldberg, 2009). Digital curriculum expands access to courseware that helps develop academic expertise, providing all learners with the opportunity to develop academic expertise.

With the growing abundance of information available, students need the intellectual tools and learning strategies to seek relevant resources, recognize what is important, and evaluate what is credible (Bransford et al., 2000). They need to understand the fundamental structures in various subject areas well enough to ask pertinent questions, think productively, and communicate effectively.

Students need integrated knowledge of facts, concepts, and strategies that will enable them to make connections and contributions to complex issues such as those related to the environment, health, and the economy (Partnership for 21st Century Skills, 2009). More than ever, education must help learners become innovators—with the ability to apply their knowledge flexibly and creatively to solve problems in new situations.

Active Learning

All sections of this paper speak to the concept of *active learning* or "a process whereby students engage in activities, such as reading, writing, discussion, or problem solving that promote analysis, synthesis, and evaluation of class content" (Center for Research on Teaching and Learning). In an active learning environment, students learn by doing, activating the brain's perception-action cycle (MIND Research Institute). In fact, few educational interventions can match the power of active learning strategies in improving student academic outcomes (Hattie, 2009).

Active learning manifests in different ways depending on the subject area and desired learning outcomes. For example:

- In a math course it may include changing values within variables to understand how parts of a system are related.
- In language arts, it may involve analyzing the motivations of a character or author and constructing arguments for a point of view.
- In science, it involves understanding how evidence is used to support a theory or make a prediction.
- In social studies, it may involve understanding how different groups of people are motivated and how those motivations come together in a historical event that affects our present world.

These examples only scratch the surface of the ways that active learning can manifest; more examples can be found by looking at state standards that emphasize what students must be able to do, rather than focusing only on facts they must know. The main point is that active learning is complex, multi-faceted, and essential for success in school, work, and life. Curriculum that supports active learning must also be multi-faceted, and creating it is complex (Clark & Mayer, 2016; Dirksen, 2016; Horton, 2012).

Research and Apex Learning Practice

The research presented in this whitepaper is divided into four sections.

Section I, Research on Teaching and Active Learning with Media, focuses on what is traditionally thought of as "teaching." An example of this is how a teacher or a media presentation shows a student how to find the area of a triangle, or how to write a topic sentence for an essay. The student must take an active part in this process to learn anything; in online curriculum, there need to be appropriately timed and communicated opportunities for the student to give input.

Section II focuses on activities and giving feedback to students to reinforce what they are learning or to correct misconceptions. Practice is essential for developing knowledge, and feedback is essential for reinforcing correct understanding and for correcting misconceptions (Black & Wiliam, 1998). Feedback also enhances motivation (Shute, 2007). This type of feedback is often called *formative assessment,* which is separate from the *summative assessment* that is used at the end of lessons, units, or courses to measure what students have learned.

Section III focuses on characteristics of learners and what they need to stay engaged and motivated. For instance, learners come to school with preconceived understandings (and misunderstandings) and interests that affect their motivation. They also come to school with varying levels of competence.

> Section IV focuses on summative assessment and effective data management to reveal student understanding and support effective learning throughout the instructional process.

Each research summary is followed by discussion of how the research is applied within the Apex Learning digital curriculum.

Section I: Teaching and Active Learning with Media

Research in the learning sciences provides a time-tested base of evidence on how people learn and how to design instruction so that students build knowledge and skills. Students learn more when information is presented via multiple media in ways that reduce unnecessary cognitive effort, facilitate processing of essential information, and maximize processing potential. These elements contribute to learning with understanding and the goal of adaptive expertise.

Modern constructivist views on learning often focus on what students do to build knowledge, and stress that too much classroom time is spent with the teacher in front of the class, explaining concepts to the entire class. Some theories have even said that learning is most effective when students can discover principles on their own, without someone telling them the principles in a lecture. Research has shown, however, that presentation of knowledge—sometimes in the form of presentations or lectures—is also necessary for learning (Bransford & Schwartz, 1998).

Organizing Information Around Main Ideas

The organization of content around central concepts that are supported by selected facts and information is an evidence-based best practice in curriculum design (Bransford et al., 2000; Wiggins & McTighe, 2005). This is a time-tested principle. In 1929, Alfred North Whitehead wrote, "Let the main ideas which are introduced into a child's education be few and important, and let them be thrown into every combination possible. The child should make them his own and should understand their application here and now" (p. 2).

Jerome Bruner, in his 1960 classic *The Process of Education*, advocated for the importance of coherence in the design of curriculum for developing student understanding:

> The teaching and learning of structure, rather than simply the mastery of facts and techniques, is at the center of the classic problem of transfer. ... If earlier learning is to render later learning easier, it must do so by providing a general picture in terms of which the relations between things encountered earlier and later are made as clear as possible. (p. 12)

Clear understanding of what, why, and how subject matter is taught is important for learners as well as teachers. Instructional goals narrow what students focus their energy on (Marzano, Pickering, & Pollock, 2001). But goals should not be so specific that they are not meaningful to students. When students personalize goals, the goals become relevant for them as learners.

Important ideas need to be presented in increasing depth. They need to be revisited with many examples and built on so that understanding grows over time in ways that increase students' ability to use and apply their factual knowledge (Bransford et al., 2000). Approaches such as problem-based and inquiry-based instruction help students make connections, develop integrated knowledge structures of facts and concepts, and understand conditions of applicability.

Multimedia Presentation of Knowledge

While approaches such as problem-based and inquiry-based instruction help students, knowledge cannot be acquired from problem solving alone (Bransford et al., 2000). In many subject areas, it is also necessary to acquire knowledge from text, lectures, or media presentations. Students are primed to acquire this knowledge when they need it to complete an analytical task or to meet a purpose, such as a problem they need to solve or a question they need to answer (Schwartz & Bransford, 1998).

Mayer (2008) presents evidence-based and theoretically grounded principles for presenting information using multimedia. Instruction that adheres to these principles improves students' learning and ability to transfer knowledge:

- Reducing extraneous processing helps prevent learners from wasting cognitive effort on activity that is not essential to learning the targeted content (Mayer, 2008). For example, extraneous processing can be reduced by good layout—text placed close to related graphics requires less effort to process than text separated from graphics—or by minimizing unnecessary material. Struggling readers especially benefit from coherent and clear presentation of content (Hiebert, Menon, Martin, & Bach, 2009).
- Managing essential processing facilitates the learning of complex knowledge, once extraneous processing has been minimized (Mayer, 2008). For example, learning improves when complex information is presented in digestible chunks, such as when a narrated animation is presented in learner-paced segments rather than being presented in one continuous stream.
- Fostering generative processing means enabling and improving learners' ability to maximize their processing potential (Mayer, 2008). For example, students learn better when knowledge is presented with a conversational rather than formal narrative style (an engaging voice creates a sense of social relationship, which makes the learner try harder to understand).
- Where possible, students should be invited to think and imagine at key points during media presentations. One study found that asking students to imagine (visualize) aspects of the human respiratory system before seeing a picture deepened their learning and enhanced transfer (Leopold & Mayer, 2015). This finding supports the overall theme of learning science research that says that more processing of information leads to more learning.

Another example of fostering generative processing is presenting knowledge with words and pictures rather than with words alone (Mayer, 2008). Multiple representations of information in online settings similarly assist student learning (Hiebert et al., 2009). These can come in the form of video, animation, audio, and interactive simulations integrated into the lessons and available for the students to access as needed. Using multiple modes of representation supports students' engagement and comprehension by explicitly making connections between text and information and the structure of concepts more visible. When multiple representations are used, students need explanation or annotations guiding them in how to make connections and in what the representations mean (McTigue, Eslami, & Reynolds, 2014).

Length of Videos, Animated Explanations, and Other Streaming Media

Most online courses include instructional media presentations such as videos. A study analyzing six million video watching sessions (which included tutorials and lectures including PowerPoint presentations, teachers talking, and Khan Academy-style videos) across many courses found that many students stop watching videos that extend more than six minutes (Guo et al., 2014). The study also found that videos should be chopped up with opportunities for interaction or checks for understanding between each piece. Furthermore, when a long video is followed with an assessment activity, students are less likely to complete the activity. The study also supported Mayer's (Clark & Mayer, 2016) findings that a casual, personal tone leads to more engagement.

Another study looked at patterns where students stop watching a video and re-watch certain portions (Kim et al., 2014). In addition to confirming the finding that shorter videos are more likely to be watched completely by more students, this study found most re-watching (stopping and watching again) happens with explanatory graphics and tutorial steps.

When media presentations are broken into small pieces, there should be opportunities for checks for understanding with helpful feedback between each section. This will be addressed in the section on activities and formative feedback.

A study of 40 college-age students found that they learned more from watching dialogue-style videos (a tutee asking for help and a tutor helping) than from watching monologue-style lecture videos (Chi, Kang, & Yaghmourian, 2017). The authors found that students watching the dialogue-style videos showed more constructive and interactive engagement behaviors such as working out the problems showed in the videos. In other words, viewers of dialogue-style videos were learning more actively.

Teaching and Active Learning with Media

Apex Learning digital curriculum aligns with comprehensive state and national curriculum content standards for rigorous middle and high school courses. With a balanced architecture of direct instruction, constructive practice, and formative feedback, the curriculum is designed to give all students access to rigorous content and to the tools they need to actively build knowledge and thinking skills. The digital curriculum adheres to research-based principles for presenting knowledge using multimedia that result in improved student learning and transfer.

Organizing Information and Actively Building Knowledge and Thinking Skills

In Apex Learning digital curriculum, the instruction and evaluation is constructed around a taxonomy of knowledge, in which different types of understanding are targeted by specific activities and assessments. A spiraling technique of gradually exposing students to a range of ideas related to a single concept helps students effectively build on prior knowledge, facilitating their ability to apply what they have learned to new concepts. This is accomplished through the use of activity types, each suited for the type of learning at hand, that are presented in increasing depth.

Critical thinking, problem solving, and questioning are integrated into all courses to support engagement and active learning. Students observe, inquire, confirm, connect, and create as they organize information and build knowledge in Apex Learning lessons. There are frequent opportunities to check one's understanding, empowering the learner to look back or ahead and control their own progress.

Each Apex Learning course is carefully crafted with a predictable, consistent, and coherent unit-lesson-activity structure to facilitate use by teachers and support for learners. This clearly presented content is helpful for adolescent learners.

Objectives are presented in ways that tap the interests of learners and effectively use technology to involve and challenge. Heeding research on active learning, anticipatory frames focus students on what they need to know and do in the units and lessons. "Big questions" and conceptual frames trigger students' curiosity and elicit their initial thoughts about the principal ideas. Not only do students anticipate what is coming and what is expected of them, but with the digital platform, the objectives also remain transparent, a click away wherever students are in the lessons. Having a window on the overall learning process improves students' progress toward the goals.

Direct Instruction: Direct instruction components in Apex Learning lessons often lead with real-world examples and with challenging questions to make the content inviting and relevant for adolescents. As students learn academic content with Apex Learning digital curriculum, they are supported with scaffolded instruction that effectively uses research-based reading and comprehension strategies—including questioning, advance organizers, summarizing, and note taking—with instructional supports available as needed to provide extra support. These active reading strategies deepen connectedness of text both online and in print.

To deepen engagement and understanding, students commonly use processes such as guided inquiry, the scientific method, and reading, writing, and problem-solving processes. Because Apex Learning curriculum is digital, the online platform seamlessly provides these instructional supports and offers benefits for comprehension over traditional instruction.

Once students are familiar with content, they have opportunities to test their understanding of what they have just learned with embedded self-assessments. Self-assessments come in a variety of formats including checkup activities, self-check games, and interactive assessments. Students get immediate corrective feedback that informs them about their understanding.

Metacognition—actively self-monitoring learning and understanding—develops as students take control of their progress through the lesson. They can move ahead when content is mastered or revisit the previous instruction, drawing on appropriate embedded supports and requesting teacher guidance as needed. Knowledge is deepened at strategic points throughout each lesson with practices, labs, journals, readings, discussions, explorations, and projects.

Constructed Practice: Practice activities help build fluency and target written communication and analysis. Labs provide practice with scientific methods, lab procedures, science terminology, and data analysis. Discussions offer asynchronous forums for students and teachers to build on one another's understanding and develop communication skills. Explorations are inquiry-based activities that invite students to explore alternative points of view or to go into more depth on a topic, often by searching in vetted websites. Journals encourage reflection, and in some cases analysis, as students evaluate their personal perspectives and relate them to concepts or apply their original insights to close reading. Projects are individualized extensions of learning.

Chunked Instruction with Frequent Formative Feedback: Frequent self-checks are designed to allow students to demonstrate understanding across the taxonomy—but the focus is on recalling, explaining, using, and differentiating. Computer-scored assessments have a similar focus. Checkups are largely about application. Teacher-scored activities and assessments extend across the taxonomy.

Multimedia Presentation of Knowledge

The presentation of information in Apex Learning is constructed to reduce extraneous process and promote student learning. It begins with consistent navigation throughout Apex Learning Courses and Adaptive Tutorials. Using the table of contents, it is easy for students to select and see the corresponding content.

Content is carefully presented so that students have appropriate access to multimodal information without being overwhelmed, and the conversational voice of the instruction stimulates learning.

Throughout activities there is a balanced mix of reading, observing, listening, watching, and doing, where effective use of text, pictures, audio, video, and interaction capture and keep learners' interest. Multiple modes of media are used in activities to deepen understanding of complex information and challenging concepts. For example, with the digital curriculum, students studying biology can learn the concept of population growth by viewing a short video on how populations use resources. They can learn about the same concept by reading illustrated text on how the human population is expanding. They can also change variables in a simulation of carrying capacity in which the consequences of population growth become immediately visible. And they can listen to audio on how technology is being used to meet population challenges—all while taking notes in a graphic organizer. Students are never presented with a long video or text passage, and they are never presented with media without an opportunity to respond to it with something other than a quiz. In this active online learning environment, deep understanding results from the range and diversity of experiences students have with content. Persistence and resiliency result from encouragement, formative feedback, and steady reminders to use all the resources at hand to solve a problem rather than walk away from it.

Length of Videos, Animated Explanations, and Other Streaming Media

Apex Learning has taken special care to present all content in small "chunks"—in learner-paced segments rather than being presented in one continuous stream—with limited content on one page of instruction. This supports research on both processing of information and student engagement. Within these small segments, prompts and interactive exercises give students frequent opportunities to check their understanding and apply what they learn.

Section II: Activities and Feedback

There's an adage that students learn by doing. Research and life experiences show that this is true for learning knowledge and learning skills.

Students develop understanding of a discipline by engaging in challenging activities that allow them to see how, where, and when important ideas and facts are relevant (Bransford et al., 2000). Students can acquire more factual knowledge when it is connected to meaningful problem-solving activities. Conversely, problem solving and other skills cannot be taught without a base of factual knowledge.

Supporting Student Practice

Findings from research synthesized by Marzano et al. (2001) indicate that student learning improves with the use of certain types of instructional strategies and supports. Use of predictions, advance organizers, and questions elicit students' prior knowledge, which is necessary for building new understanding. Summarizing and guided note-taking can aid comprehension by helping students determine what is most important.

It takes considerable time and practice to learn with understanding, and research shows that students must be familiar with the skill being developed for practice to be an effective learning support; otherwise, practice may simply reinforce misconceptions (Bransford et al., 2000; Marzano et al., 2001). A key to successful practice is checking for readiness before students practice and then providing corrective feedback immediately afterward.

While some students master these strategies and supports easily, others benefit from instruction that scaffolds their use until students become independently proficient with them (Marzano et al., 2001). Strategies and supports that can be readily integrated into online instruction include automated concept maps, graphic organizers, and prompts for predicting and summarizing, which can be used online or printed and used manually (Hiebert et al., 2009).

Teachers can help students learn new content by designing instruction that takes students' existing understanding and misconceptions into account (Bransford et al., 2000). In order to use what learners know to guide instruction, students' understanding must be made visible. Learners can show what they know by demonstrating understanding according to a taxonomy of cognitive abilities such as explaining, applying, and generalizeing (Anderson & Krathwohl, 2001; International Center for Leadership in Education, 2009; Keene, 2008). These different types of understanding are often presented as a hierarchical progression through levels, but best practices in instructional design show that they can be used flexibly and simultaneously, depending on learning goals.

Students can share their understanding using multiple modes of expression (e.g., draw, chart, graph, write, speak, present). Using multiple expressions with varying levels of abstraction supports learners' ability to think flexibly about complex domains and transfer knowledge to new situations (Bransford et al., 2000). Students can demonstrate their understanding through projects and performances in addition to discussions, interactive simulations, and tests. Projects and performances also provide motivation for mastering content and opportunities for cycles of revision and feedback (Barron et al., 1998).

Another important reason for making students' thinking visible is to help students develop metacognition, or active monitoring of their own learning and understanding (Bransford et al., 2000). Metacognition includes making sense of new content, assessing one's understanding, and reflecting on one's learning—practices that increase students' responsibility for their own learning and increase their ability to apply new knowledge to different situations. Online curriculum increases opportunities for students to engage in learning that integrates important practices like metacognition (Hiebert et al., 2009).

Scaffolding

Scaffolding is assistance provided before or during student actions. An example of scaffolding is a chart that shows the elements of a five-paragraph essay and provides space for students to write their thesis sentences and paragraph topic sentences. Scaffolding comes in many forms depending on the subject matter, the learners, and the learning outcomes desired. The concept is based on the work of one of the first educational theorists, Lev Vygotsky. Scaffolding is intended to help students practice more skillfully than they would be able to do on their own (Roth & Radford, 2010). Scaffolding can be provided in the form of static information (e.g., a chart or guide), information provided in context (e.g., a hint for a particular problem or step), or by a teacher providing guidance to a student. Scaffolding in computer-based environments and in classrooms has been found to be highly effective (Belland, Walker, Kim, & Lefler, 2017; van de Pol, Volman, Oort, & Beishuizen, 2015), but only when properly designed and executed.

Feedback and Formative Assessment

Feedback is information about how a student is doing in her efforts to reach a goal. Scaffolding and feedback sometimes overlap, and the distinction between the two is usually made based on whether feedback is given after a student does something (feedback) or before or during the time when the student does something (scaffolding). When immediate feedback is given for a small step while practicing a procedure or skill, it can also be considered to be scaffolding.

Each piece of feedback is based on an assessment of what a student has done, and this type of assessment is called *formative assessment*.[1] Feedback is a crucial and a complex part of supporting student learning that has been widely studied. To be effective, feedback should be goal-referenced, tangible and transparent, actionable, user-friendly, timely, ongoing, and consistent (Wiggins, 2012). Feedback that merely praises students ("You're smart!"), focuses on the student rather than on the task, or that is vague, is ineffective. Reviews of curricula and teaching practices involving millions of students have shown that ineffective feedback is at least as common as effective feedback (Hattie, 2012).

In education, much attention is given to formative assessments that report student learning results. However, learning actually improves most when assessments are used formatively to guide instruction (Black & Wiliam, 1998). Formative assessments are used during instruction to make students' thinking and understanding visible.

Formative assessment reveals information about learners' preconceptions, misconceptions, current depth of understanding, and readiness for learning new concepts. Formative assessment is one of the most effective strategies that can be used to make student understanding visible and improve learning (Bransford et al., 2000).

Formative assessment lies at the heart of effective instruction—this is where the expert's knowledge can guide the novice. Student learning improves when the teacher, as the pedagogical and content expert, uses formative assessments to make informed decisions about what students have learned and what instruction is needed (Alexander & Murphy, 1998; Black & Wiliam, 1998; Vygotsky, 1986). This expertise allows the instructor to provide feedback and instruction that guides the students in developing their content expertise. Formative assessment is not only useful for helping students, but also for instructors and curriculum designers who use it to improve their methods.

[1] Formative assessment is given to students so they can improve while they are learning, while *summative assessment* is reported as student outcomes and grades. Summative assessment is discussed in the forthcoming section on Summative Assessment and Digital Data Systems.

The key to using activities formatively is turning the information they provide into timely and specific feedback that informs subsequent teaching and learning (Black & Wiliam, 1998). Formative assessment activities can come in many forms (e.g., multiple-choice or constructed-response tests, discussions, observations, performances, portfolios, or projects) and can be designed to reveal varying levels of understanding (e.g., recall, application, or generation); (Anderson & Krathwohl, 2001; International Center for Leadership in Education, 2009; Keene, 2008; Wiggins & McTighe, 2005).

Timely and Specific Formative Feedback

The effectiveness of formative assessment to improve learning and teaching depends on timely and specific feedback followed by opportunities for learners to revise and improve their thinking (Black & Wiliam, 1998). Characteristics of feedback useful for improving learning include the following:

- Feedback should be given immediately after testing (Black & Wiliam, 1998; Marzano et al., 2001). Feedback is most effective when it is still relevant to the learner's task.
- In an online quiz setting where students answer questions, feedback was shown to be more effective when given immediately after each answer and when an explanation was given about whether the answer given by the student is correct or incorrect (Van der Kleij, Feskens, & Eggen, 2015).
- Feedback that is "corrective" in nature with explanations of mistakes has a positive effect on achievement, while simply indicating right or wrong has a negative effect (Black & Wiliam, 1998; Marzano et al., 2001). Effective feedback provides information that can help students understand how their thinking compares to their learning goal, and that can help them attain that learning goal.
- Feedback should be specific to a criterion rather than a comparison with other students (Black & William, 1998; Marzano et al., 2001). Feedback that includes grades or emphasizes performance in competition with other learners can have a negative effect on learning. Consistent with literature on goal orientation, achievement improves when the focus is on the students' effort and the task (learning orientation) rather than the students' ego and ability (performance orientation), even when feedback includes praise.

Students can effectively provide some of their own feedback through self-assessment (Black & Wiliam, 1998; Marzano et al., 2001). Activities that include self- and peer-assessment help students take more responsibility for their own learning, which builds capacity for future learning.

Student Control and Metacognition

As students take increasing responsibility for their own learning, the possibility of transferring their new learning to future situations increases (Alexander & Murphy, 1998; Vygotsky, 1986). Instruction that integrates metacognitive skills—self-assessment, reflection, sense-making, and self-regulation—into the curriculum across multiple subject areas can help students take increasing control of their own learning (Bransford et al, 2000; Winstone, Nash, Parker, & Rowntree, 2017).

Students' learning improves when instruction involves cycles of formative assessment, feedback, and revision (Barron et al., 1998; Vye et al., 1998). Through scaffolded feedback cycles, students can engage in increasingly independent practice and self-monitoring that lead to deeper understanding.

Support Every Step of the Way

A common theme in research on scaffolding, formative assessment, and formative feedback is that students need assistance every step of the way throughout instruction. When learning a new concept or skill, even more scaffolding, assessment, and feedback are needed. As competence develops, these supports can be gradually reduced. However, a teacher needs to monitor a student's progress and step in whenever help is needed.

Activities and Feedback Research

Practice

Constructive practice is a key element of Apex Learning digital curriculum. Practice follows direct instruction so students are familiar with the skill and practice is effective. Practice segments are directly related to the instruction provided, and allow students to apply learning and thinking skills obtained in the instruction.

Practice occurs frequently throughout the digital curriculum; it is not reserved for the end of a large segment of instruction. Both computer-scored and teacher-scored practice opportunities are woven throughout the curriculum. Students are provided with immediate feedback that provides direction and corrections, not just recognition of the correctness/incorrectness of the response.

Scaffolds and Supports

Apex Learning embeds scaffolding in the structure of its digital curriculum to serve as a bridge that builds upon what students already know to help them arrive at something they do not know (new learning). Apex Learning digital curriculum includes both strategic scaffolds aimed at increasing the comprehension capacity of learners and adaptive scaffolds which are changes to content or texts that make them more accessible.

Strategic Scaffolds	Adaptive Scaffolds
• Reminders and coaching on making predictions, asking questions, clarifying confusing parts, and summarizing • Structured overviews • Modeling • Active reading strategies: accessing prior knowledge, making predictions, using context and visual cues, making inferences, asking questions, making mental images, monitoring, and summarizing	• Controlling the amount of information/ideas on a page • Graphic organizers • Multiple representations • Multiple modes • Real-world contexts • Meaningful feedback • Information about unknown words • Examples of successful products (like a summary)

Apex Learning provides supports that students opt into (choose to activate or use) as they need them, such as linked vocabulary or support cards. In addition, tools provide digital, interactive versions of common offline tools and manipulatives. This includes resources such as math manipulatives and simulations of processes and procedures.

The supports and tools differentiate instruction: more advanced students can accelerate through instructional content, while proficient students can make less frequent use of scaffolds and supports. Struggling students can access as often and as many times as needed.

Feedback and Formative Assessment

In Apex Learning, formative self-assessment comes in the form of frequent online self-checks that provide students with immediate computer-generated corrective feedback, freeing teachers' time from grading and giving students control over their progress through the lesson.

As students answer questions, they are provided with immediate formative explanations and guidance that goes beyond simple indications that the response was correct or incorrect. This type of feedback provides meaningful support for correct answers (why the answer was correct) and answer-specific guiding feedback for incorrect answers. With multiple opportunities to check their understanding, students are free to make mistakes without the accompanying embarrassment that might go with making an error in front of their peers.

Teachers provide timely feedback based on student information revealed on teacher- and computer-scored activities. Teacher-scored activities primarily assess higher-order understanding and in many cases involve reflection, creativity, original thought, argument, and analysis. There are also frequent computer-scored quizzes throughout lessons that assess recall, comprehension, and application.

Student Control and Metacognition

During Apex Learning lessons, students develop increased control over their learning and improve their metacognitive skills. Students control the pacing of activities and self-check assessments. They also have responsibility for the use of optional study aids. With the help of timely digital- and teacher-provided feedback, students learn to monitor their understanding and improve their own learning. Understanding deepens as students' independence increases through instructional cycles involving assessment.

Support Every Step of the Way

During Apex Learning lessons, students have access to a variety of built-in scaffolds and opt-in supports that provide them with immediate access to the resources and tools they need to successfully master the instructional content. As students become more competent, they can choose to use fewer and fewer of these supports.

Section III: Learners

This section discusses important findings about learners and creating learner-centered environments. First, learning improves when instruction takes account of factors that contribute to engagement. Second, students engage more and try harder when tasks are meaningful to them. Third, instruction should take into account learners' prior knowledge and misconceptions. And finally, students benefit from differentiated instruction tailored to their readiness and skills, including their reading and language abilities.

Student Engagement

Learning depends on students being engaged in learning activities. Engagement is defined and measured in different ways and usually is described as having behavioral, cognitive, and affective elements. One instrument for measuring school engagement is the Student Engagement Instrument. It has been used to determine factors that contribute to and detract from engagement. In a 2006 analysis of responses to the instrument's items from 1,931 ninth grade students (Appleton, Christenson, Kim, & Reschly, 2006), the most important factor was found to be social—whether teachers care about students and whether the environment is safe physically and emotionally. The second most important factor was related to curriculum and is characterized by statements such as:

- The tests in my classes do a good job of measuring what I'm able to do.
- Most of what is important to know you learn in school.
- Learning is fun because I get better at something.

The first two statements are directly related to curriculum design, including the design of tests and quizzes. Related to the last statement, learning improves when students' progress toward instructional goals is made explicit (Bransford et al., 2000; Vye et al., 1998) and students have the tools they need to make progress. For instance, students have enhanced opportunities to monitor their own learning when an overview of the learning process remains visible and their attention is directed to it as instructional milestones are reached. Studies of online learning have found that interactions that allow students to monitor their own understanding improve learning outcomes (Means et al., 2010).

Prior Knowledge and Misconceptions

A learner's initial knowledge serves as the foundation for all future learning, determining how new experiences and information are interpreted (Alexander & Murphy, 1998; Brandt, 1998). Students come to the classroom with preconceptions—and often misconceptions—about content they will learn in school.

If students' initial conceptions are not made visible and addressed through instruction, students may only learn new facts and concepts superficially, clinging to their original misconceptions (Bransford et al., 2000). These lingering misconceptions form a faulty basis for future learning and can thwart understanding of new content and concepts.

The implication of this for teaching is that there is a need to elicit students' pre-existing knowledge and skills, and to build on them in the teaching of new content—at the beginning of instruction and as learning progresses (American Psychological Association [APA], 1997). Instruction that is based on learners' understanding will necessitate offering additional supports for some students and advanced challenges for others. Students' needs will change as instruction proceeds, and learning improves when instruction is continually attuned to these changing conceptions (Bransford et al., 2000).

Building on current knowledge to progress through courses in specialized content areas presents special challenges for adolescents who are weak readers. Research on adolescent literacy provides insights on helping struggling readers meet rigorous demands of academic subjects (Kamil, Borman, Dole, Kral, Salinger, & Torgesen, 2008; Lee & Spratley, 2010), each of which has its own technical vocabulary, syntax (way of using language), and ways of using elements like diagrams and charts.

There is strong evidence for the value of providing explicit vocabulary instruction and explicit reading strategy instruction—including the use of predicting, inferring, visualizing, questioning, summarizing, and more (Kamil et al., 2008). Strategies such as these make thinking visible and make both students and teachers aware of misconceptions. While these strategies are important for all readers to learn and use, explicit instruction calls for teacher modeling, explanation, guided practice with feedback, and independent practice with scaffolding as needed.

In addition, struggling readers can benefit from discipline-specific strategy instruction including emphasis on reading comprehension with modeling and guided support for making sense of text before, during, and after reading (Lee & Spratley, 2010). Research on learning with digital media has found that learners learn more deeply when cues are added to highlight the organization of the essential material (DaCosta & Seok, 2010). As important as these supports are for those who need them, it is just as important that students who do not need the supports are not encumbered by them.

Making Learning Meaningful

People are motivated to learn what is meaningful to them (Brandt, 1998). Key factors that contribute to making learning meaningful include the learner's emotional states, beliefs (such as the role of effort in achievement), interests, goals, and intellectual habits (such as persistence through ambiguity) (APA, 1997, Costa & Kallick, 2008; Marzano et al., 2001).

Motivation can be stimulated by difficult but achievable tasks that engage individuals to use their higher-order thinking skills and exert effort over an extended period of time (Brandt, 1998). Problem-based learning and inquiry-based instruction are two practices designed to engage students in challenging activities (Bransford et al., 2000).

Motivation to learn can also be stimulated by personally relevant goals, which can be developed when individuals have personal choice and control (Brandt, 1998). Adolescent learners benefit from activities they perceive as relevant to their lives and from those that build confidence (Kamil et al., 2008; Lee & Spratley, 2010).

For example, a study of high school students found that learners' engagement increased when the perceived challenge of the task and their own skills were high and in balance, the instruction was relevant, and the learning environment was under their control (Shernoff, Csikszenihalyi, Shneider, & Shernoff, 2003). In another study, middle school students' learning improved when the instruction used media effectively to engage a range of readers in complex problem solving, was anchored in a simulated real-world context, involved generating and evaluating multiple feasible solutions, and demanded extended time to complete (Cognition and Technology Group at Vanderbilt, 1997).

Findings from research synthesized by Hiebert et al. (2009) on online learning and engagement echo the findings on engagement relevant for any type of learning. As in any context, adolescents are motivated when they believe they have some control over their learning. For instance, adolescents who believe that their own effort contributes to their ability to read, rather than it being a given ability, are motivated to persevere in a task even when it is difficult. Similarly, students are motivated by online content that is challenging but achievable, as well as personally relevant and interesting.

Hiebert et al. (2009) also report that digital learning offers unique motivational benefits, in part because the online environment itself is motivating to students. In addition, student interest and expertise improves with online opportunities for student control (e.g., choice in the pace at which text is presented and in having sections reread) and engagement (e.g., having texts and tasks at the appropriate level). Together this presents a significant opportunity for making learning meaningful through digital curriculum.

Learner Readiness

In their own ways, learners progress through various common stages of development. Learning at each stage is most effective when developmental readiness is taken into account (APA, 1997; Vygotsky, 1986). This includes readiness in terms of physical, intellectual, emotional, and social factors. It also is determined by the understandings, strategies, skills, and habits that learners bring to each new learning task (Bransford et al., 2000). As Costa and Kallick (2008) wrote, "All kids do learn, but not on the same day and not in the same way" (p. 13). Effective learning requires quality curriculum and quality instruction designed to meet students where they are.

As students go through similar stages of development, they can work toward common rigorous goals with individually differing support (Tomlinson & McTighe, 2006). Differing support includes adjusting the content, format, or pacing of lessons to address students' needs, strengths, weaknesses, and interests (APA, 1997; Brenner, 2009). For instance, instruction in a unit may be differentiated by including scaffolds for students weak in reading skills while challenging others to stretch their communication skills to more complex levels.

Online environments afford special opportunities for addressing learner readiness through differentiated instruction. With increased flexibility in when, where, and how learning occurs, online contexts offer a way to break through the scheduling constraints that so often limit school learning time (Cavanaugh, 2009). In online courses, students can control how much time to spend on each activity, choosing to move quickly through tasks to avoid boredom or revisiting previous lessons to bolster understanding. For some students, the online environment provides the emotional security needed to overcome social insecurities that hamper ability to focus on academics in traditional classroom environments, allowing students to prosper with digital curriculum (Watson & Gemin, 2009; (Hiebert et al., 2009).

Findings from research synthesized by Hiebert et al. (2009) shed light on ways to differentiate instruction by using adaptive and strategic online scaffolds to support struggling and disengaged adolescents' comprehension. Online scaffolds help readers by increasing their access to grade-level content and texts, which in turn increases their engagement.

Use of adaptive scaffolds (e.g., online help with vocabulary and text-to-speech support) enables readers to learn with content that is above their independent reading level (Hiebert et al., 2009). Strategic online scaffolds incorporate instruction on effective use of strategies (e.g., predicting, questioning, and summarizing) into grade-level content. With technology such as virtual tutors, responsibility for the use of online scaffolds can be adjusted from mandatory to independent as learners progress.

Supporting Struggling Readers

Struggling readers benefit from the affordances of online curriculum. Multimedia design principles, such as placing visual representations in a location and context that allows for simultaneous processing (visual and

verbal) without the two channels competing with each other (Clark & Mayer, 2016). All readers, and especially struggling readers, benefit from:

- explicit vocabulary instruction;
- direct and explicit comprehension instruction; and
- opportunities for extended discussion of text meaning and interpretation (Kamil et al., 2008).

Struggling readers, in particular, benefit from intensive and individualized intervention (Kamil et al., 2008) and from text-to-speech or recorded audio of the text being read (Stodden, Roberts, Takahashia, Parka, & Stodden, 2012).

Supporting English Language Learners

Students who are learning English as a new language may be competent readers in their original language, or they may face the same difficulties as other struggling readers and thus will benefit from the same curricular features described above.

The government-funded *Report of the National Literacy Panel on Language-Minority Children and Youth* found that English language learners benefit from literacy in their first language, and thus their existing literacy skills should be used to their advantage (August, Shanahan, & Escamilla, 2009). Students' home languages and cultures should be respected and acknowledged. Wherever possible, culturally-relevant materials should be used. Within content areas, skills for analyzing and understanding text should be explicitly scaffolded (Tretter, Ardasheva, & Bookstrom, 2014).

The College Board recommends, based on its research, that curriculum be challenging and also accessible (Li, 2012). One way to make content accessible is through the use of meaningful and clear diagrams and other graphics (Wright, Eslami, McTigue, & Reynolds, 2015).

Other measures to make curriculum accessible include:

- slow and clear speech;
- regularly check for understanding; and
- encouraging continuing to develop one's home language (Ferlazzo, 2016).

Learner Research

Apex Learning digital curriculum meets students where they are and develops their capacities. It provides differentiated instruction for all students by considering pre-existing conceptions, making learning activities meaningful, and enhancing access to curriculum based on learner readiness.

Student Engagement

Active learning is a key element in engaging students in Apex Learning. Student interaction with the digital curriculum is frequent and meaningful. These frequent elements requiring student input not only require the student to stay engaged, they also serve as a series of self-checks where students can monitor their own learning and course correct as needed.

The multi-media rich curriculum is organized in digestible chunks so students are never overwhelmed with information.

Using the student dashboard tools, students can monitor their progress and celebrate instructional milestones as they occur.

Prior Knowledge and Misconceptions

In Apex Learning digital curriculum, students are asked to respond to instruction in ways that reveal their preconceptions and misconceptions throughout learning. Students' initial thinking is elicited early in lessons with conceptual frames and "big questions." Strategies such as discovery-confirmation, making observations, questioning, predicting, and using advance organizers before, during, and after make thinking visible and reveal misconceptions. Activities such as discussions, practices, and journals provide additional opportunities in which prior knowledge is taken into account. In Adaptive Tutorials, recommended remediation activities provide support in building grade-level skills.

Making Learning Meaningful

Apex Learning puts the research on making learning meaningful into practice in its digital curriculum. First, anticipatory frames, in real-world contexts, capture students' interest, eliciting their prior knowledge and piquing their interest in the content to come.

Next, a variety of activities offers the right level of challenge to make tasks challenging but achievable, which increases engagement. Engaging tasks involving problem solving, questioning, and critical thinking also foster intellectual habits like persistence, ability to handle ambiguity, and belief in self-efficacy—all important for improving learning as well as providing students with important college- and career-readiness skills.

Third, with 24-hour access, the option to set one's own pace, to choose the use of supports, and the ability to self-monitor through frequent checks of understanding, students increase their control over their learning—another component of making learning personally meaningful.

Finally, Apex Learning lessons effectively use media to engage learners with multiple modes of representations, a balanced variety of activities (e.g., guided inquiry and practice, direct instruction, and interactive manipulatives that encourage students to make discoveries), and even the opportunity to develop expertise in using the media.

Learner Readiness

Students are motivated to do better when the bar is higher. Apex Learning courses set the same bar and shared expectations for all students, but there is flexibility for each student to reach and exceed the bar in his or her unique way and in his or her own time. Thus, with Apex Learning digital curriculum, learners with varying levels of readiness can obtain the same rigor in different ways.

Apex Learning courses include online scaffolding that increases student access to grade-level content. Adaptive text scaffolding includes clickable access to text transcripts for audio, to vocabulary definitions, and to reading support cards that model reading strategies. Making text accessible in multiple ways is a technique supported by CAST's Universal Design for Learning Guidelines (2008) for curriculum, which accommodates diverse abilities. Strategic scaffolding is included in lessons to support comprehension while also increasing access to grade-level content and building a capacity for increasingly independent learning. As understanding of grade-level content increases, so does student control and engagement, leading to improved student learning.

Unlike static content, there is flexibility in Apex Learning for students to shift between paths according to their differing and growing readiness in each subject area. General studies courses and content are available in multiple pathways, all with the same scope and sequence, that can be differentiated in these ways:

- Instructional content that provides structured remediation in math, reading, and writing to meet the needs of both high school students and transitioning middle school students who are not prepared for grade-level academic challenges
- Instructional content that assumes student readiness for grade-level academic challenges, but also includes targeted scaffolding for students who benefit from additional learning support
- Instructional content designed to meet the needs of students seeking to accelerate their learning and deepen their conceptual understanding with many opportunities to apply, extend, and synthesize knowledge
- College Board-authorized Advanced Placement courses that prepare students to demonstrate college-level achievement through success on the AP exams

Supporting Struggling Readers

Embedded scaffolding and opt-in supports in Apex Learning are designed to provide students who need additional assistance with the scaffolding they need to master rigorous content. Scaffolds and supports that assist struggling readers include:

- Text and visual context clues to help students connect words with meaning
- Explicit vocabulary instruction and embedded linked vocabulary
- Opt-in Reading Support, Check it Out, and Rediscover support cards that provide students with reading strategy (Reading Support), real-world information (Check it Out), and reminders and prerequisite knowledge (Rediscover)
- Study sheets provide students with an organizational model for notetaking, identifying important information, preparing for tests, and more
- Read aloud options and transcripts

Supporting ELL Students

The same scaffolds and supports that bolster struggling readers also assist English language learners in developing new language skills. The design of the lessons is rich with context including multiple representations, real-time support, and real-world ideas to which students can connect. Transcript, translation, and text-to-speech tools provide additional support for students new to the English language.

Section IV: Summative Assessment and Digital Data Systems

This section establishes the importance of using summative assessment and data to reveal student understanding throughout the learning process.

Summative Assessment

Summative assessments are used to measure and report learning outcomes, rather than to inform instruction and improve learning (APA, 1997; Black & Wiliam, 1998). Summative assessments provide information for recording grades and comparing groups of students.

Typically used at the end of an instructional unit, these assessments must align with the unit's learning goals (Bransford et al., 2000). Ideally, unit-based summative assessments also align with state and national accountability measures.

Digital Data Systems

Online environments offer opportunities for entering, generating, sharing, and utilizing assessment data with less effort and faster results than possible in traditional school practice, even when that is partially automated (Partnership for 21st Century Skills, 2009). As part of a transparent system, this availability of data supports improvements in student learning at the individual, classroom, and school levels. It can make formative and summative information readily available to students, teachers, administrators, and parents in real time.

Digital data systems provide opportunities for increased school time, which is linked to higher achievement (Cavanaugh, 2009; Farbman, 2009). In addition to bypassing constraints of the traditional school day with anywhere/anytime access, instructional time increases when automated data input, access, and reporting reduce time required for non-instructional activities.

Assessment and Feedback Research

The Apex Learning digital curriculum seamlessly provides formative and summative assessment and data to reveal student understanding throughout the learning process. Information about learner knowledge guides teachers in planning instruction and informs learners about their progress during lessons. No-stakes and low-stakes assessments are embedded within the direct instruction and throughout units of study. Summative achievement is measured in high-stakes assessments at the end of units and semesters. Integrated online data and reporting systems facilitate the management of student data and make formative and summative assessment information available to students, teachers, and administrators in real time.

Summative Assessment

At the end of each instructional unit and semester, there are high-stakes computer-scored and teacher-scored tests to report student achievement. These summative tests align with unit and course learning objectives as well as with comprehensive state and national curricular standards.

Digital Data Systems

Apex Learning offers a central role to teachers that is dramatically different from traditional practice in ways research confirms are valid, meaningful, and essential to outcomes. With digital curriculum and data on student progress available in the online grade book, the teacher has more time to spend individualizing instruction: guiding activities, differentiating instruction, recognizing achievement, providing encouragement, and providing one-to-one support. Using timely data and insights from regularly scheduled meetings with the students (face-to-face, online, or by phone), the teacher can provide just-in-time acceleration, remediation, or extension.

Conclusion

The science of learning provides an established base of research and practice on how people learn and how to design instruction so that students learn with understanding. This paper documents how Apex Learning puts the research into practice in its digital curriculum.

Use of properly-designed multimedia instruction in digital curriculum has been shown to improve student achievement. These principles include thoughtfully using media to support teaching, presenting information in a conversational tone, and breaking media presentations into small pieces.

Apex Learning content is carefully designed so that students have appropriate access to multimodal information without being overwhelmed, and the conversational voice of the instruction supports engagement and learning. This digital curriculum adheres to research-based principles that result in improved student learning and transfer.

With a balanced architecture of direct instruction, constructive practice, formative feedback, and support every step of the way, Apex Learning courses are designed to give all students access to rigorous content and to the tools they need to actively build knowledge and thinking skills.

Research on learners suggests that learning improves when instruction takes account of learners' prior knowledge, that students engage when tasks are meaningful, and that students benefit from differentiated instruction tailored to their readiness. Apex Learning digital curriculum meets students where they are and develops their capacities. It provides personalized instruction for all students by taking into account preexisting conceptions, making learning activities meaningful, and enhancing access to curriculum based on learner readiness.

Research on formative assessment states that learning improves when students receive formative feedback that is timely and specific. This feedback helps students develop the ability to reflect on their own progress and adjust their understanding and skills accordingly. While formative assessment directly improves learning, summative assessment plays an important role in measuring outcomes and accounting for progress.

The Apex Learning digital curriculum seamlessly provides formative assessment and summative assessment data to students and teachers, to reveal student understanding throughout the learning process. Information about learner knowledge guides teachers in planning instruction and informs learners about their progress during lessons. Summative achievement is measured at the end of units and semesters. Integrated online data and reporting systems facilitate the management of student data and save time for students and teachers. They also make important information available to teachers and administrators in real time.

Designed in accordance with time-tested research principles, Apex Learning digital curriculum gives all students access to the content and tools they need to achieve in an environment of academic rigor.

About the Researcher

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Tom Baer has a Ph.D. in Learning Sciences from the University of Washington College of Education. He studied technology supports for high school science students and completed his dissertation studying problem-based learning in medical students. He is responsible for instructional design, learning technology, and evaluation at the Alliance for Child Welfare Excellence at the University of Washington School of Social Work. In this role, he supports the design and delivery of curriculum for foster parents and social workers. Previous to that, he was an educational technology specialist at the University of Washington School of Nursing, which has been successfully using innovative distance learning technologies to increase access to nursing education. He began developing challenge-based, interactive learning technology in 1994 when he was the lead instructional designer on the award-winning *Science Sleuths* CD-ROM series. Since then he has designed and produced a wide range of online courses for high school and adults in the K-12, corporate, and higher education sectors. Tom's interests include interaction design, the role of challenges in making meaning, and building communities.

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