Acellus® Learning Accelerator™

Courseware Development Guide for Educators

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INTERNATIONAL ACADEMY OF SCIENCE

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Chapter 1:
VISION OF ACELLUS

Learning Needs: As Diverse as Learners

All students – the ones who struggle and the ones who soar – deserve the opportunity to achieve their full potential.

We developed Acellus to apply science to the learning process, using advanced technology and feedback analysis to meet the needs of the diverse students schools need to serve. Schools that have adopted Acellus report reduced dropout rates, increased graduation rates, and growing success helping students transition to careers and college studies. Read some of their stories later in this chapter.

This book tells the story of Acellus – what it is, how it works, and how to use it to achieve desired outcomes.

What is Acellus?

Acellus is an interactive learning accelerator. It combines technology and learning science to help students learn more efficiently (in less time) and more effectively (with greater mastery) (Figure 1.1).

Figure 1.1: Acellus speeds the learning process for every student.

Backed by scientific research, Acellus delivers online instruction, compliant with the latest standards, through high-definition video lessons made more engaging with multimedia and animation. Each lesson is carefully designed to connect with previously-learned knowledge like interlocking building blocks. Students can log in to take lessons from school or home, on any device. The next time they log in, they're right where they left off.

Personalized instruction. Acellus adapts course delivery to the individual student using Intelligent Interaction technology. After watching each video, students work assessment items that reinforce their understanding of that topic for formative (during course) and summative (end-of-course) assessment. Students can advance to the next lesson as soon as they demonstrate mastery of the concept. When assessments reveal that a student is struggling, Acellus slows down and digs in, providing minor or major remediation and practice until the assessment shows the student is ready to move forward.

Less time spent on record keeping, more time for personalized attention. Acellus offloads much of the time-consuming work of grading so that teachers can devote more time to motivating students and helping them learn.

Teachers can closely monitor each student's progress from the Acellus Live Class Monitor (Figure 1.2). A quick glance shows which students are struggling and need more attention. In addition, Acellus Performance Reports help teachers identify students who are not succeeding and provide recommended intervention strategies. Teachers approve recommendations with a click of a button, and then Acellus immediately puts the plan into action.

Continual improvement. The Acellus Learning System is designed to discover what does and does not work in the learning process. Continual refinements make

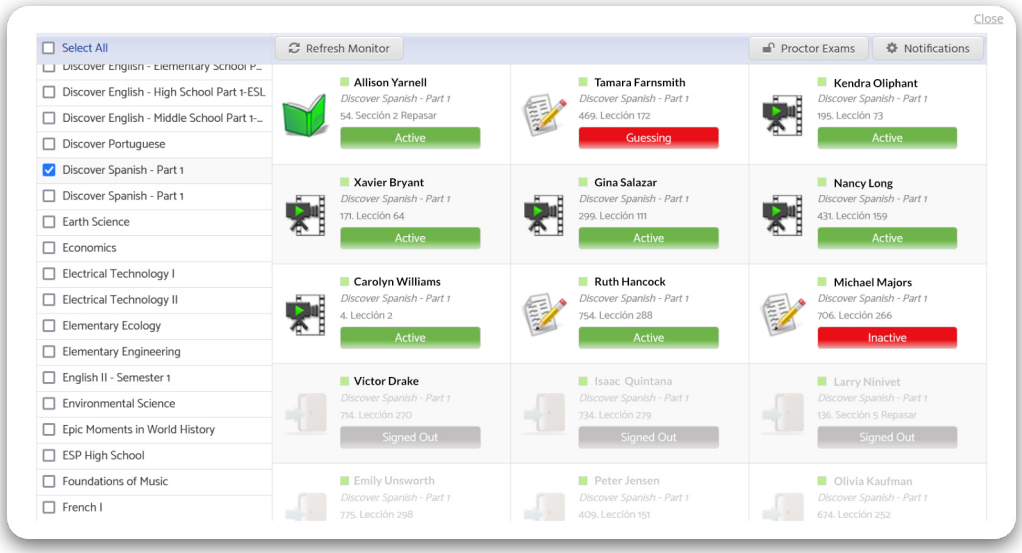


Figure 1.2: Acellus Live Class Monitor provides teachers with real-time information on the status of each student.

course content more effective. Every night Acellus collects that day's student response data, which Acellus course developers study to better understand the learning process. The following night Acellus publishes new content that reflects insights from collected student responses. This continual feedback loop makes the learning experience constantly more effective.

Real-World Results

After implementing Acellus, superintendents, school administrators, and teachers report significant gains in their standardized test results, accelerated student academic growth, and a notable decline in dropout rates.

STEM Lab Teaches 21st Century Skills

Agra Public Schools, Agra, OK

"Since we implemented the Acellus STEM Lab, student interest in coding has increased exponentially. The Acellus STEM Lab has been a hit with both teachers and students. Teachers like the problem solving skills, students love the robot! (Figure 1.3).

Figure 1.3: Acellus Live Class Monitor provides teachers with real-time information on the status of each student.

"As a rural elementary school, we had neither the teacher nor the curriculum to offer coding. The Acellus STEM Lab has been a game changer. Students are motivated and engaged. Our teachers are impressed with the problem solving and critical thinking skills their students are learning."[1]

Supporting Diverse Learning Needs

Lake Chelan School District, WA

"Using Acellus in our K-12 Special Education program has provided our school district a powerful tool to support the diverse learning needs of our students. Acellus gives schools individualized core instruction adaptable at each

[1] *Jeff Kelly, Superintendent – Agra, OK*

Figure 1.4: Acellus is a learning accelerator. It has helped many students graduate who otherwise would not have finished their coursework.

student's learning level while providing built-in specialized resources through differentiation, customized note taking, and progress monitoring. Acellus accompanied by specially designed support for each student is a recipe for success!"[2]

Credit Recovery Success

Crosby-Ironton Schools, MN

"I want to let you know how pleased I am with the Acellus Learning program. This past summer we had 60 out of 74 students who had failed one or more classes recover all of their credits through the wide range of Acellus courses available to them. Acellus truly helps students stay on track so they can graduate on time!"[3] *(See Figure 1.4)*

Deep, Diverse Content

Fedonia Jr. Sr. High School, KS

"Our first year with Acellus has been a tremendous success! The content provided through Acellus is much deeper and more diverse than what we have been accustomed to. Our students, parents, and adult learners have been very enthusiastic about our switch to Acellus."[4]

More Positive Attitudes Toward Learning

Chino Unified School District, California

"Some of these students who were struggling in Math, at home or in a school setting, and were frustrated and discouraged, once they went on Acellus, they were now encouraged. They were feeling they were getting better, they were learning, they were getting it. There was a light bulb that just said, "Hey I love math now!" When I started hearing that kind of feedback from my own students and the parents, I knew that Acellus was a great thing."[5]

[2] *Kelly Kronauer, Special Program Director – Lake Chelan, WA*
[3] *Jim Christenson, Principal – Crosby, MN*
[4] *Aaron Chard, Director of 21st Century Learning, Fredonia, KS*
[5] *Sarah Sy, Instructor – Chino Unified School District, CA*

How to Put Acellus to Work in Your School

Choose a Deployment Model

Are you using Hybrid Learning? The U.S. Department of Education has reported that students with access to a combination of online and face-to-face instruction excel in relation to peers exposed to only one method of instruction.[6]

In addition, a survey in January 2022 found that 62% of all public schools offered a hybrid of remote and in-person instruction.[7]

Hybrid learning with Acellus is a comprehensive method of education that combines in-person instruction with online accelerated learning. Hybrid Learning is resulting in tangible gains in student achievement, including the improvement of standardized test scores and higher retention rates. Since the learning process is being accelerated, struggling students quickly catch up to grade-level expectations. Recent research conducted by the Institute of Education Sciences suggested that accelerated learning can be the key to helping students successfully complete more grade-level assignments.[8]

Acellus enables educators and administrators to adopt hybrid learning in a way that targets specific areas of need in their school communities, using any combination of popular models.

The following models have been identified for hybrid learning:

Rotation model – Students rotate between online and face-to-face instruction.

Students rotate either on a fixed schedule or at the teacher's discretion. In some schools and courses students rotate among online learning, small-group instruction, and pencil-and-paper assignments at their desks (which may be at home). In others they rotate between online learning and some type of whole-group class discussion or project. In either case the clock or the teacher announces that the

[6] *"Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning," U.S. Department of Education, 2010*
[7] *2022 School Pulse Panel, Institute of Education Sciences, Release Date March 2022, https://ies.ed.gov/schoolsurvey/spp/*
[8] *District Leaders: Do your students practice accelerated learning?, Micah Ward, District Administration Magazine, August 10, 2022, https://districtadministration.com/district-leaders-do-your-students-practice-accelerated-learning/*

time has arrived to rotate, and students shift to their next assigned activity. The Rotation model includes four sub-models:

- Station rotation
- Lab rotation
- Flipped classroom
- Individual rotation

Flex model – An online course provides the backbone of student learning and is augmented by a face-to-face teacher.

The teacher of record is on site, and students learn mostly at a brick-and-mortar campus except when doing homework. Students move through a Flex course at their own pace, and the on-site teacher is on hand to offer help. In many programs the teacher initiates projects and discussions to enrich and deepen learning.

A la carte model – The course is taken entirely online to accompany a traditional brick-and-mortar program.

Students can take a la carte courses either on campus or off-site. Students take some courses a la carte and others face-to-face at the brick-and-mortar campus.

Enriched Virtual model – An online course that includes required face-to-face learning sessions.

Figure 1.5: With Acellus Team Teach, teachers can bring Acellus into their classroom without a computer lab and create group collaboration.

Many enriched virtual programs begin as full-time, online schools and then develop hybrid programs to provide students with brick-and-mortar school experiences. The enriched virtual model differs from the flipped classroom model because students typically do not meet face-to-face with their teachers every weekday. It differs from a fully online course in that face-to-face learning sessions are required, not optional or social events.

No Computer Lab? Team Teach

Many teachers use Acellus to supplement direct instruction during the school day (Figure 1.5), selecting specific steps or concepts to show in class using a projector or large display.

Teachers can select specific video lessons from any Acellus course to enhance and vary the day's instruction. After presenting the videos, teachers can lead group discussions on the topic, fostering collaboration between learners. Some educators use Team Teach in class and direct students to log into Acellus to complete their homework online. The corresponding lesson plans are already created and homework is graded automatically, giving teachers more time to focus on teaching.

Choose Programs

Schools around the U.S. are successfully using Acellus for programs ranging from Special Education and Credit Recovery to Gifted and Talented Education.

Special Education

The Acellus Special Education program is based on years of research by the International Academy of Science on how special- needs students learn. The program applies proven methodologies to effectively reach these students so they can quickly begin experiencing success in courses with standards-based rigor.

Acellus Special Education courses, given the SEd designation, are specifically designed for students with special needs, and include tools to assess, adapt, and individualize course material. Students can spend as much time as they need to approach or meet grade-level expectations.

Science, Technology, Engineering, and Mathematics (STEM)

Acellus STEM-10 prepares students for high-tech careers directly from high school (Figure 1.6). Unlike the usual games associated with STEM, STEM-10 is a cohesive 10-year program and a serious educational endeavor.

Coding begins in the third grade and becomes more advanced each year. In the ninth grade, students branch into a career and technical field that matches their interest.

Figure 1.6: In the STEM-10 Level 2 coding course, students learn to program the AC-D2 robot – a robot that can walk, talk, dance, and sense distance.

Coding instruction is delivered right through the Acellus system, making it suitable even in classrooms where a STEM-trained teacher is not available. The video-based coding courseware adapts to each student's individual needs, allowing schools to personalize the STEM instruction to each learner's level and skill set.

Credit Recovery

When students start falling behind in their coursework or failing classes they need to graduate, timely intervention is imperative. Acellus provides an expansive selection of self-paced courses that students can complete on a flexible schedule. The courses help students bridge the gap between where they are academically and where they need to be in order to complete grade-level material.

Many schools that begin by using Acellus for Credit Recovery later shift to using it for remediation, to preempt failure. The result is a smaller Credit Recovery program – a good outcome.

Advanced Placement

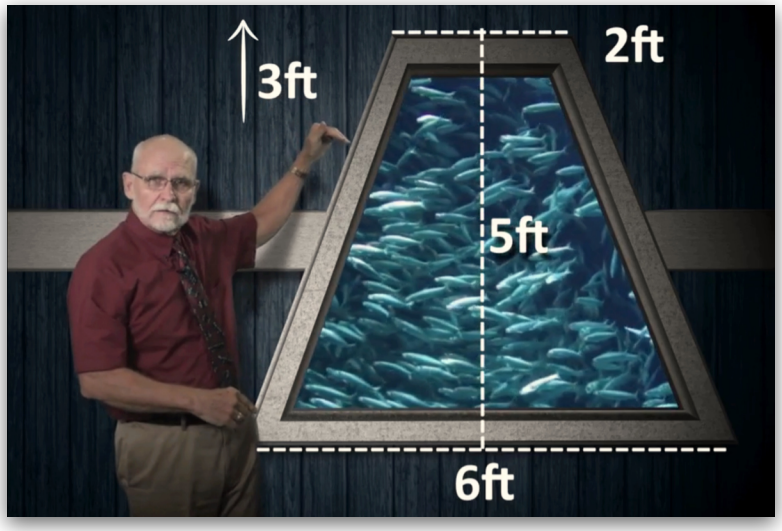


Figure 1.7: Patrick Mara teaches AP Calculus AB and BC, as well as an AP Calculus AB Prep course. Mr. Mara has taught calculus at the high school and college levels, is a veteran AP Calculus teacher, and has served as an AP Exam reader.

Acellus offers an extensive selection of College Board-approved AP courses, allowing students to earn college credit while in high school. Acellus AP courses are rigorous but adaptive. The goal is to empower students not only to pass the test and acquire credit, but also to lay a firm foundation for future college studies.

Acellus AP courses are taught by certified AP instructors with years of experience teaching and preparing students for these rigorous exams (see Figure 1.7). Acellus AP courses have been audited and approved by the College Board, making students eligible to receive college credit upon successful completion of the course and exam.

GED and Adult Education

Schools and adult learning centers can choose from an extensive selection of resources to provide academic and career training. To pass a high-school equivalency exam, students need a strong foundation in literacy, mathematics, social studies, and science – the four core areas tested by the GED, HiSET, and Test Assessing Secondary Completion (TASC). Acellus courses in each core area are specifically developed for each section of the exam. Students who lack the academic foundation to complete GED-level material can also take prerequisite courses through Acellus.

Career and Technical Education

In the influential article "The Silent Epidemic – Perspective of High School Dropouts," the authors reported that nearly half (47 percent) of people who had dropped out of school said a major reason was that "classes were not interesting."[9] These students did not see a link between the curriculum and the real world they would enter after high school.

Figure 1.8: Acellus Career and Technical Education (CTE) courses prepare students for future careers.

Acellus CTE courses supplement or significantly expand CTE programs, combining academic anchor standards with the career and life-skills training essential for success in the real world (see Figure 1.8). Students can take courses specific to their chosen career pathway. The course curricula adhere to state CTE guidelines while qualifying students to take industry-recognized certification exams. This opens the way for them to move into entry-level positions right out of high school.

Independent Study

Schools need options for educating students outside of the brick-and-mortar school environment when students have health problems, are parents, work to support their families, or for various reasons cannot thrive in a regular classroom setting. Acellus gives students the opportunity to study from home – on their own schedule – without compromising academic rigor, standards, or quality.

[9] *John M. Bridgeland, John J. Dilulio, Jr., Karen Burke Morison, "The Silent Epidemic – Perspective of High School Dropouts," Civic Enterprises, 2006*

Ensuring the academic integrity of a virtual independent study program can be challenging and time consuming for teachers and staff. Acellus automates much of the mundane work – logging every student login, answer, and grade, and generating reports – so that teachers can devote their time to educating students.

Intervention

With courses for academic as well as social and emotional learning, Acellus supports schools offering Response to Intervention (RTI) and Multi-Tiered System of Support (MTSS) programs. As a targeted intervention tool, Acellus links prescriptive assessments to customized content based on the student's skills and individual needs.

Using Prism Diagnostics® technology, Acellus identifies specific gaps in students' knowledge that make it difficult to learn a new concept. If gaps exist, the student receives additional instruction.

Figure 1.9: Dr. Pajét Monet addresses the issues of Social and Emotional Learning in her elementary, middle school, and high school courses.

Social Development

Today's educators are expected not only to engage students in learning but also to create an environment of positive thoughts and behaviors (Figure 1.9).

Research shows that social and emotional learning improves student achievement by an average of 11 percentile points, significantly improves student attitudes and behavior, and reduces depression and stress.[10]

Acellus Social Development courses help students understand and cope with their emotions, learn how to cultivate healthy relationships, and have a caring attitude toward others. Courses are available for elementary, middle, and high school levels.

Summer School

Acellus provides diverse course offerings for summer school. For students who have fallen behind, schools

[10] *Joseph Durlak, Roger P. Weissberg, Allison Dymnicki, Rebecca Taylor, & Kriston Schellinger, "The impact of enhancing students' social and emotional learning: a meta-analysis of school-based universal interventions," Child Development, January/February 2011, Volume 82, Number 1, Pages 405-432*

can offer a complete credit recovery program. Basic courses needed for remediation help students complete the necessary grade-level courses and prepare them to pass end-of-course exams. For students on the other end of the spectrum, Acellus offers honors courses as well as a full suite of College Board-approved Advanced Placement courses.

After-School Programs

The pressure of preparing students for high-stakes testing in math and English Language Arts (ELA) leaves little time for enrichment activities such as STEM and robotics programs. Acellus After School programs provide help for struggling learners while giving other students an opportunity to engage in enrichment activities that may not fit into the regular school schedule.

Gifted and Talented

High-achieving learners often need specialized instruction to realize their full potential. Providing a varied educational experience that meets these students' needs is an ongoing challenge that is difficult to address in a traditional classroom.

Acellus offers different levels of instruction so that students with advanced skill levels are not held back. An accelerated mode of Acellus, specifically developed for gifted students, features courses taught on a more advanced level than the traditional course, helping to keep gifted learners engaged.

Teachers choose the mode for each student. Acellus Success Zone reports suggest when to move students into the accelerated mode of a course (see Figure 1.10).

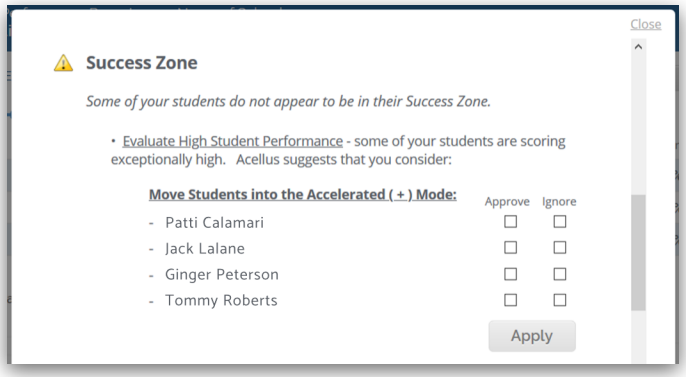


Figure 1.10: Teachers can use the Teacher Aids Screen (shown here) to set high achievers to accelerated mode, or can use the Reposition Screen (Classes → select class → Reposition Students).

Teacher Development

Through its Institute of Science and Technology (IST) program, the International Academy of Science (IAS) offers a Master of Education in E-Learning program for educators interested in being able to set up and operate an effective e-learning program for their school. In addition, IST offers

a Doctor of Education in E-Learning degree program for individuals interested in e-learning and desiring the ability to apply this understanding to make positive contributions to society. These programs give graduate students hands-on experience, applying both content and pedagogical knowledge in online and hybrid learning through the use of the Acellus CybrEducation Program.

English as a Second Language (ESL)

Approximately one in ten public school students is an English Language Learner (ELL).[11] As a result, schools across the country find themselves in the predicament of having to teach core academics for graduation without having the ability to verbally communicate with students. In some schools, the English Language Learners (ELL) program includes native speakers of more than 50 different languages.

The Acellus Discover English course teaches the English language and communication skills students need to thrive in school and the workforce. Developed for students in ESL Programs, Discover English is effective for students from any ethnic background. It uses the Universal Interaction Technique developed by Acellus to instruct students of various native languages simultaneously.

Discover English trains students on the syntax, vocabulary, and pronunciation they need to comprehend English in an everyday environment. This course is suited for students learning English for the first time as well as ESL students who need extra practice and help. Discover English can be used on its own or to supplement classroom teacher instruction in a blended or hybrid learning environment.

Correctional Education

Hundreds of thousands of incarcerated adults and juveniles leave prisons and detention facilities each year. While many successfully transition back into their communities and become productive members of society, many others commit new crimes and are re-incarcerated.

According to a RAND study, "[i]nmates who participate in any kind of educational program behind bars – from remedial math to vocational auto shop to college-level courses – are up to 43 percent less likely to reoffend and return to prison."[12]

Providing education to youths incarcerated in juvenile correctional facilities has been linked to lower recidivism rates and better reintegration rates when inmates

[11] *Claudio Sanchez, "English Language Learners: How Your State Is Doing," NPR Ed, February 23, 2017*

leave detention. Education is a crucial service for correctional facilities. The two-fold challenge is providing education to a transient population with varying levels of mastery and doing it without Internet access.

Acellus has overcome these challenges by developing a media server that does not require a network connection. Inmates can access all Acellus educational lessons and complete their coursework without ever accessing the Internet.

College Prep

Acellus offers several courses for students preparing for college:

- *Investigating Careers* provides an overview of various careers – many of which students may not be familiar with – along with the education, training, and skills required for each.
- *College and Career Readiness* imparts the basic knowledge and skills students need to set attainable goals leading them onto a path of success.
- Specialized exam prep courses for college entrance and AP exams familiarize students with test question formats and provide time-management tips for test day. Knowing what to expect on a high-stakes test is almost as important as knowing the material covered.

[12] *"The Case for Correc□onal Educa□on in U.S. Prisons," RAND, January 23, 2016*

Chapter 2:
THE SCIENCE BEHIND THE ACELLUS LEARNING ACCELERATOR™

So what is the "secret sauce" that makes Acellus work like magic? It's science. Building on modern research, Acellus developers study the way students learn, identify obstacles to learning, and experiment with different techniques rooted in cognitive science to discover the ones that accelerate learning. This chapter describes the science behind the Acellus Learning Accelerator.

- Continual Feedback
- The Success Zone Philosophy
- Prism Diagnostics
- Vectored Instruction
- Improving Memorization with Cognitive Thinking
  - Repetition
  - Mnemonics
  - Spaced Repetition
  - Skirting Working Memory to Create Long-Term Memories from the Outset
  - How Acellus Puts Cognitive Science to Work

Continual Feedback

Acellus collects feedback to continually refine the learning process. The feedback process occurs every night, when the current day's student response data is uploaded to the Acellus system for analysis by researchers at the International Academy of Science (Figure 2.1). Here's the process:

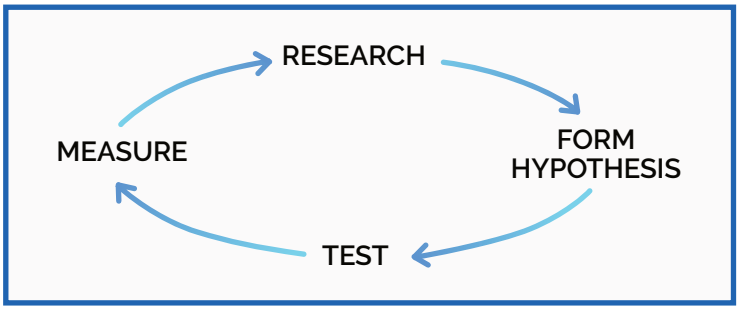


Figure 2.1: Acellus incorporates the scientific method and feedback process.

- Researchers study student responses to find areas where many students have difficulty.
- They form a hypothesis to explain why the concept is particularly challenging.
- They modify course content to test the hypothesis.
- Revised content is released to Acellus servers each evening.
- The Acellus system compiles student response data to new assessment items to measure whether student understanding has improved.
- If student understanding did not improve, researchers form a new hypothesis and repeat the feedback cycle.

Through the scientific method and the power of feedback, Acellus researchers continually improve their understanding of how students learn, making the learning process more relevant, engaging, and effective.

The Success Zone Philosophy

Students who are not succeeding become discouraged. Some may feel like failures or lose hope that they will ever move forward and succeed. While teachers on the front line know how to motivate students, they don't have the time to personalize instruction for each student's needs – those who struggle and those who excel.

To address the factors inhibiting student success, Acellus researchers developed the Acellus Success Zone model. The premise is that 100% of students can succeed, where success is defined as making forward progress in the course with an average score of 70% or better. Success Zone gives teachers the data and intervention options to help students move forward. The outcomes are improved benchmarks such as attendance, course completion, diploma readiness, and college preparedness.

Here's how the Success Zone works:

- Students start the Acellus course in Normal Mode – the pace and complexity appropriate for the majority of students. The Acellus system continually monitors each student's progress and performance, flagging students who are unable to achieve at least 70% on lessons and exams. These students are potentially wasting their time struggling – not learning.
- When a student struggles in the course, Acellus recommends moving the student to the Tuned Learning (TL) Mode. This version of the course presents lesson content at a pace tuned to the learning of the student and might include videos with more basic content. Students doing exceptionally well in a course, on the other hand, while still being considered in their Success Zone, may benefit from an extra challenge. Acellus recommends moving these gifted students to the Accelerated Mode which presents more comprehensive lessons and additional, more rigorous assessment items.
- Recommendations are compiled monthly into an online Performance Report that teachers can view at any time (Figure 2.2). The report shows the

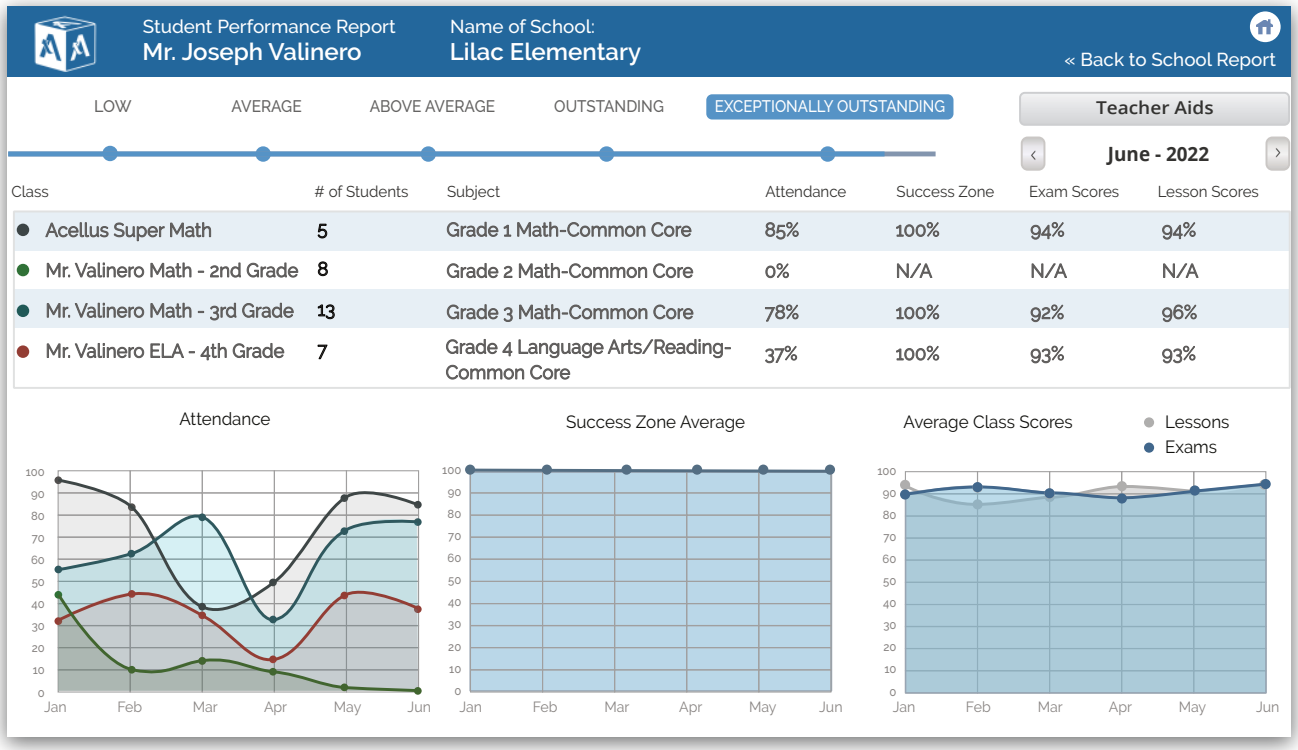
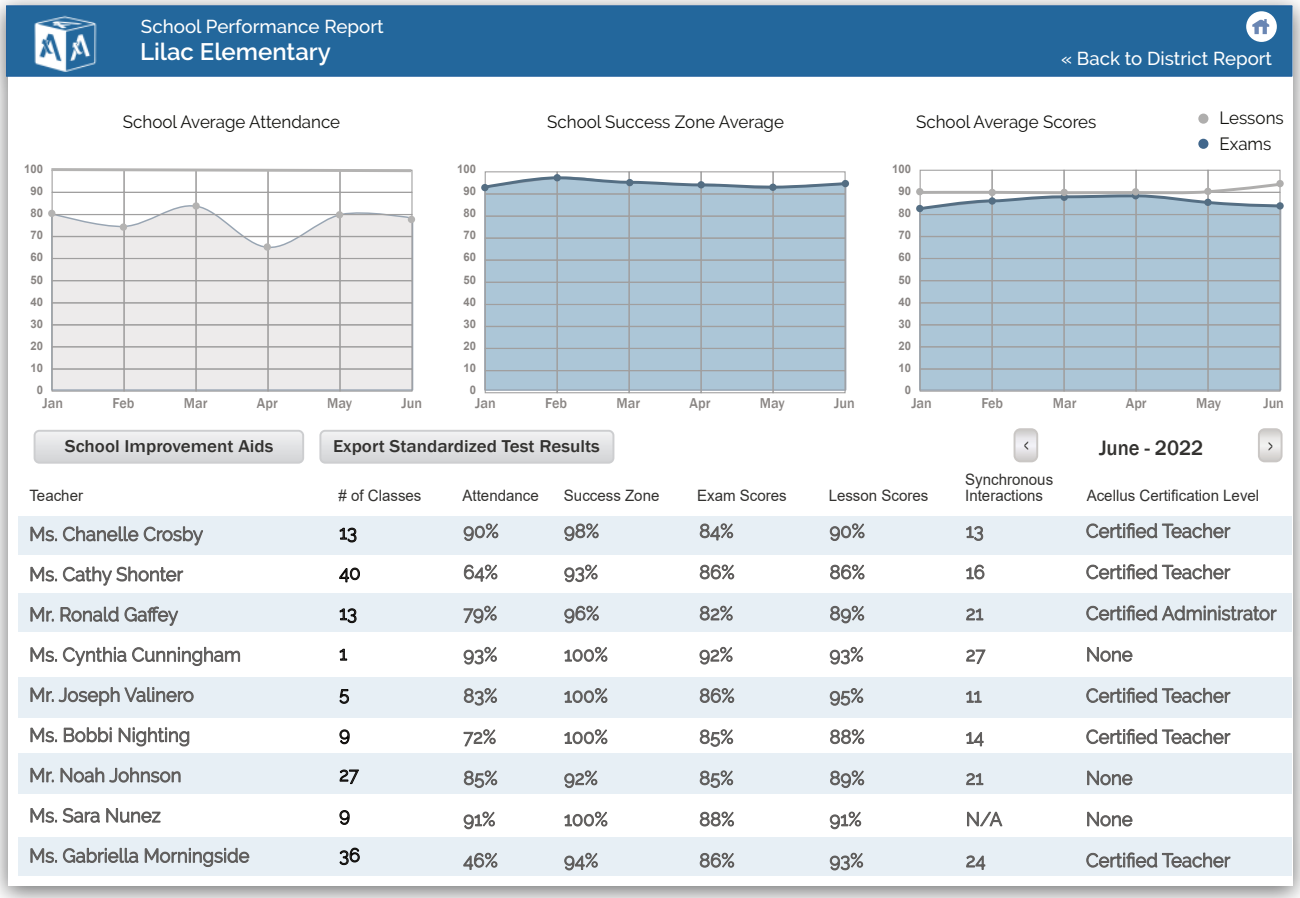


Figure 2.2: The Student Performance Report gives teachers details on their own classes. Teacher Aids help them assign appropriate interventions.

percentage of students in the class working in their Success Zone, which students are outside their Success Zones, overall attendance, and average class scores. The report also provides specific recommendations on how to help struggling students and increase class scores – for example, encouraging students with poor attendance to consistently log in and complete their online coursework or moving students to Tuned Learning Mode or Accelerated Mode. Teachers approve the recommendations at their discretion and changes take effect right away.

Principals can view the School Performance Report to quickly see how well students are performing in each teacher's classes (Figure 2.3). The report shows the school's average attendance, Success Zone average, and lesson and exam averages. Principals can drill down deeper to see additional details. School administrators and board members can view district-wide Performance Reports to compare schools. All reports are updated monthly and show historical trends and progress.



Teacher	# of Classes	Attendance	Success Zone	Exam Scores	Lesson Scores	Synchronous Interactions	Acellus Certification Level
Ms. Chanelle Crosby	13	90%	98%	84%	90%	13	Certified Teacher
Ms. Cathy Shonter	40	64%	93%	86%	86%	16	Certified Teacher
Mr. Ronald Gaffey	13	79%	96%	82%	89%	21	Certified Administrator
Ms. Cynthia Cunningham	1	93%	100%	92%	93%	27	None
Mr. Joseph Valinero	5	83%	100%	86%	95%	11	Certified Teacher
Ms. Bobbi Nighting	9	72%	100%	85%	88%	14	Certified Teacher
Mr. Noah Johnson	27	85%	92%	85%	89%	21	None
Ms. Sara Nunez	9	91%	100%	88%	91%	N/A	None
Ms. Gabriella Morningside	36	46%	94%	86%	93%	24	Certified Teacher

Figure 2.3: The School Performance Report gives administrators significant data on how students are doing throughout the school.

Prism Diagnostics®

Prism Diagnostics (Figure 2.4) is made up of multiple modes or categories, each one designed to detect a specific problem or condition regarding student learning, thereby enabling the appropriate action or response. Here are the diagnostic modes and how each is detected by the system:

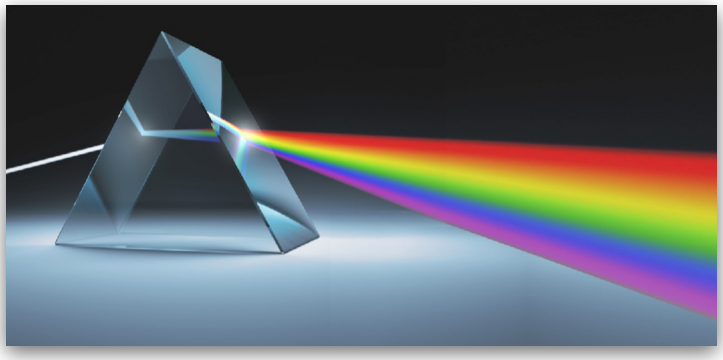


Figure 2.4: Like a prism separating light into colors, Prism Diagnostics separates students into groups based on similar deficiencies.

"Stuck" Mode

After completing a video-based lesson, the student gets "stuck" when trying to work the assessment items for the lesson. In Acellus, "stuck" is never good and is not acceptable. "Stuck" students quickly become discouraged and negative.

Whenever a student is asked to work an assessment item as part of a lesson, a Help option is provided on the same screen as the assessment item (see Figure 2.5). Students learn to reach out for help in this manner, knowing that doing so will not negatively impact their scores. The system responds with Help Videos, which will be discussed in the next section.

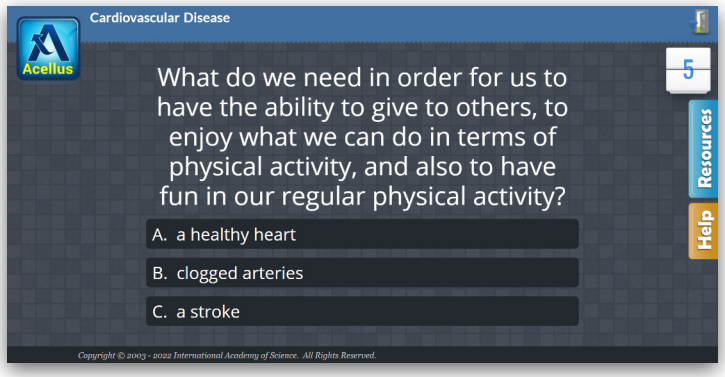


Figure 2.5: Students can access the Help tab at any time while working assessment items after a video. The help tab is also available during reviews and recovery.

Wrong Answer Analysis

Every time a student enters a response to an assessment question, Acellus checks the answer to see if it is correct. If the answer is not correct, the system searches the database to see if the incorrect answer entered is one of the "special" wrong answers recognized by the system. Sometimes, specific holes in students' understanding of a concept can be identified by analyzing their answers.

As a simple example, consider an assessment question asking students how many days are in a week. Students who answer "7 days" have entered the correct answer and have demonstrated that they understand the concept of this lesson. Students who give the wrong answer of "30 days" are confusing weeks with months.

Students who answer "365 days" are confusing weeks with years. In either case, they are demonstrating a need for narrowly-targeted instruction.

Wrong Answer Analysis is a powerful learning deficiency diagnostic which, when used properly, provides the ability to give struggling students the exact help required, precisely when it is needed.

Progress Analysis

The Success Zone mentioned earlier is an Acellus tool focused on student success and progress. It is a powerful tool to identify when students have a chronic need for help.

Sometimes a simple fix is not enough. In these cases, Acellus provides each student with in-depth instruction referred to as the Recovery Mode. Student Progress Analysis consists of a complex set of algorithms which include rate of progress, overall scores on lessons and exams, and other components as applicable. All of these parameters are analyzed on a periodic basis to identify when a student would benefit from the Recovery Mode.

Vectored Instruction

When Acellus, using Prism Diagnostics, detects a deficiency, it instigates specialized instruction targeting the specific deficiency. This process is referred to as Vectored Instruction. It operates differently in response to each diagnostic mode.

"Stuck" Mode – Special Help Videos

In the "stuck" diagnostic mode, students are unable to work assessment items, so they reach out for help by selecting the Help button. At this moment, the system knows exactly which assessment item the student is working on and is therefore able to instantly pull up a Help Video lesson that covers the same assessment item the student is trying to work but with different values or parameters. Watching the teacher work the assessment item on the screen helps the student see how to proceed but does not give the answer. After watching the Help Video, the student is again challenged to answer the original assessment item.

The Acellus system monitors the frequency of students needing Help Videos. Using this data, the courseware development team evaluates enhancements they could make to the main lesson video that would better prepare students to answer assessment items. They also evaluate the assessment items themselves to

see if they could be made more clear. On lessons teaching difficult concepts, special "instructive pre-assessment items" are added to the lesson which are given to students before the assessment items and often are effective in preparing students to handle the full-fledged assessments that follow.

The philosophy of Acellus is to provide immediate support, seeking to empower students to be able to work assessment items rather than just giving them the answers. In addition, lesson and exam assessment items are provided to students randomly so that students do not all get the same set of assessment items.

Wrong Answer Analysis – Deficiency Recovery Videos

Wrong Answer Analysis is one of the most powerful and effective tools in Acellus. At the very moment a student enters a wrong answer, the system responds with a deficiency recovery video targeting the specific flaw it discovered by analyzing the wrong answer.

Many times the reason students get discouraged about learning is that they keep getting things wrong and they cannot figure out why. They finally give up, thinking they are just "stupid" – a tragic conclusion, leading to other failures and problems. Often, the deficiency is the result of some simple concept they have missed, often years before, which is now needed to learn the new material of the present lesson.

When the deficiency recovery video feature of Acellus went live, school districts reported a measurable difference in the attitudes of students using the system, including improved scores on standardized tests and lowered dropout rates.

Progress Analysis – Vectored Instruction

The Student Progress Analysis tool identifies students with chronic deficiencies. These students are placed in the Recovery Modes to help them get back on track.

With trial and error, researchers observed that when students with chronic deficiencies were placed far enough back into classes below grade level, they began making more progress in their learning. However, this created problems since students often needed to be put back multiple grade levels. Putting students below their grade level was discouraging to some students and created problems for school districts required by law to have students in grade-level classes.

The solution was Vectored Instruction – the best of both worlds. It was born of the realization that even when students are behind, they only need specific lessons

from past courses. A special database was created for each lesson of a course, listing the concepts taught in the lesson and identifying lessons from prior courses that taught concepts students would need to be able to master the new material.

Vectored Instruction builds on the "mental models" theory articulated by Kenneth Craik in his 1943 book *The Nature of Explanation*. According to Craik, mental models are an individual's own view of reality. A young student's mental model of a dog, for instance, might be that it's furry, it comes in a variety of colors and sizes, it likes to fetch, and it sometimes bites. Children's simplistic mental models are often riddled with misconceptions and falsehoods. As the child grows and matures, these models become more complex – and, it is hoped, more aligned with reality.

The smallest learning component is a *knowledge bit* (Figure 2.6). The dog attributes mentioned above are knowledge bits. *Concepts* are groups of knowledge bits that provide meaning when they are brought together. Until there's a concept, it is difficult to know what to do with knowledge bits – or to retain them. Remembering the string l-e-p-i-n-c is more difficult than p-e-n-c-i-l because the latter is part of a concept. Remembering the string 0-1-1-2-3-5-8-13-21 is easier if the learner understands that it is a Fibonacci Sequence describing the spiral shape in nature, where each number is the sum of the two preceding numbers.

Education helps students accumulate bits of knowledge and relate them to a concept. As learning continues, the concept becomes more sophisticated and begins to interconnect with other concepts. Interconnected concepts form a master con-

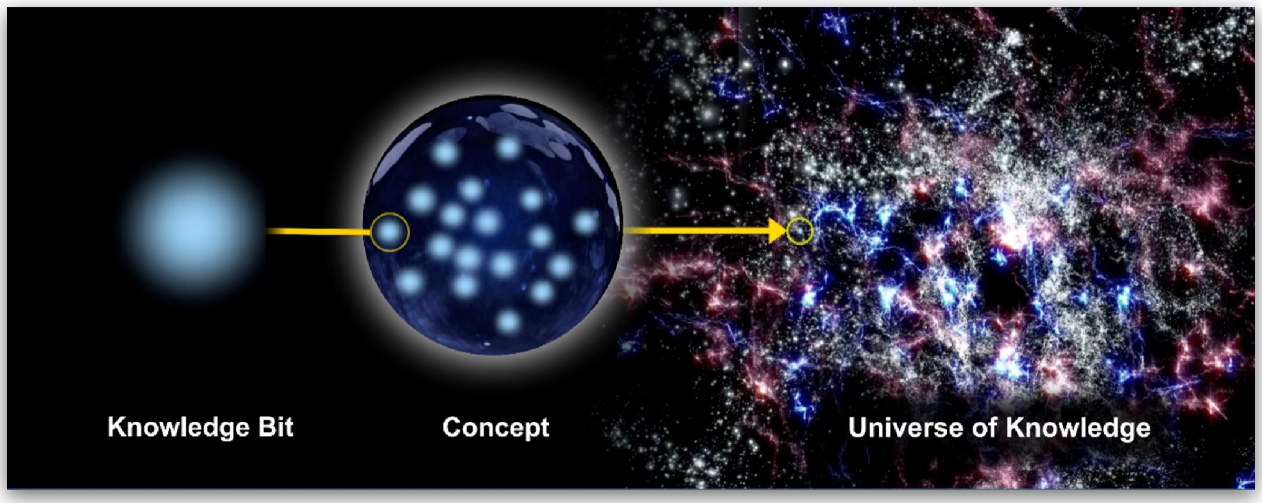


Figure 2.6: Interlinked knowledge bits form concepts; interlinked concepts form a person's universe of knowledge.

scious model – the universe of knowledge illustrated in Figure 2.6. The more students learn, the more complex their universe of knowledge becomes.

Figure 2.7: Curriculum directors assemble need-to-know concepts to formulate a curriculum.

Curricula contain the need-to-know concepts identified by curriculum development teams. It's the job of educators to make sure that students master these concepts (Figure 2.7).

In Acellus, each lesson conveys a concept. Students who are stuck are presented with remediation, right when the assessment item is fresh on the student's mind. The remediation is presented with the right magnitude and direction (like a vector) to fill the hole in understanding and put the student back on course. Vectored Instruction, illustrated in Figure 2.8, works like this:

- Researchers analyze student response data and diagnose deficiencies.
- Researchers analyze the concept of a lesson and determine which previously-learned foundational concepts are required to master this new material.
- Acellus provides laser-precision instruction targeting the student's unique deficiency.

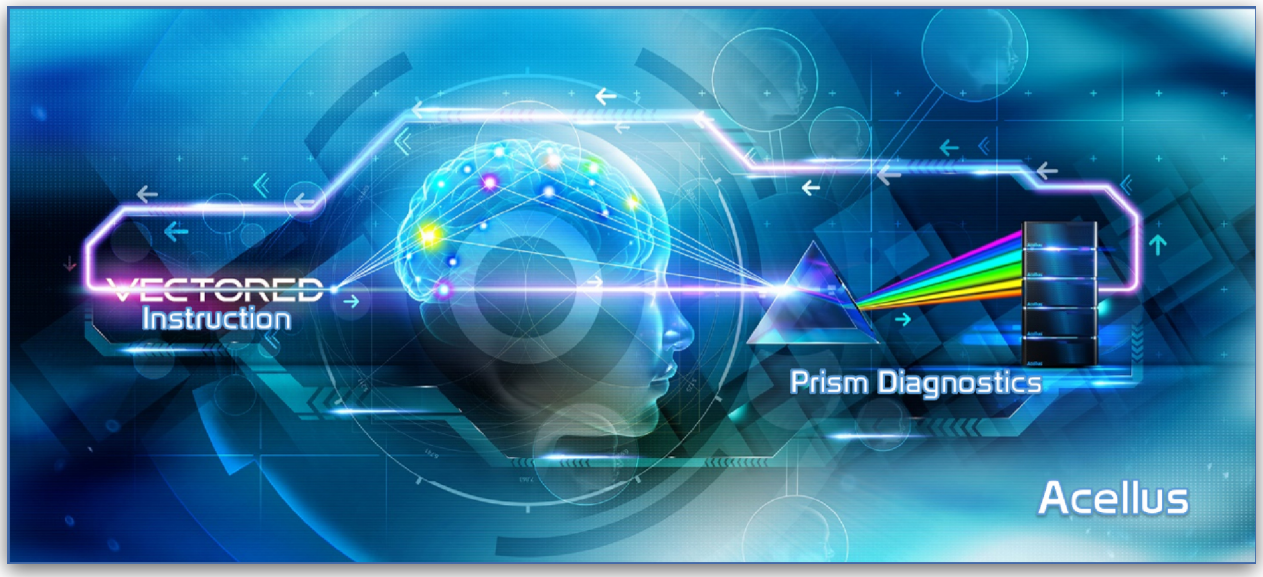


Figure 2.8: Using Vectored Instruction Acellus discovers and targets concepts that students are missing and that are stopping them from acquiring more knowledge. Once students understand these concepts, they can move forward again – and succeed.

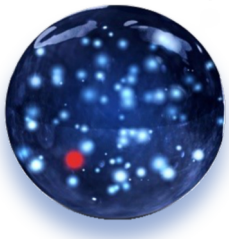


Figure 2.9: Deficiency recovery videos help correct minute flaws.

When a student has a small defect in understanding, deficiency recovery videos provide targeted instruction to fix a minute flaw, empowering the student to move forward again (see Figure 2.9). For small deficiencies, this is all that is needed.

Other times, however, students have a chronic problem. They are not sufficiently prepared for the course that they are in. Vectored Instruction focuses on solving this more challenging problem. Vectored Instruction, when needed, is deployed in three levels:

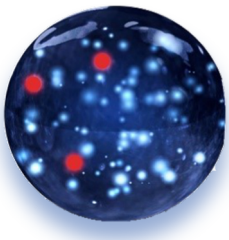


Figure 2.10: Students with a persistent deficiency go into Recovery Mode.

- When Acellus diagnoses a persistent deficiency, students first go into Recovery Mode, where they receive more basic instruction and practice on the concept they are struggling to master (Figure 2.10). Teachers see a notification on the Live Class Monitor, and the event is recorded in the student's personal data for the course.
- A student who continues to struggle transitions into Deep Recovery Mode (Figure 2.11). Here the content delves deeper into the concepts the student is missing. Now the vector has more force behind it – Vectored Instruction goes further back into the things the student needs to learn.
- A student who is still not progressing after Deep Recovery Mode transitions to Foundation Building Mode. This mode starts from scratch to build a whole new mental model of the concept that the student either learned incorrectly or missed.

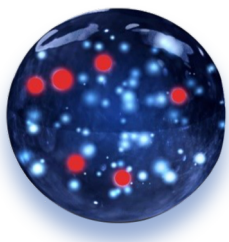


Figure 2.11: Deep Recovery Mode helps students delve deeper into missing concepts.

When students break through and have the needed foundation, they emerge from Vectored Instruction precisely where they were in their course. Teachers see the transition on the Live Class Monitor. A student who has been progressing in the grade-level course suddenly comes to a standstill, is transitioned to Vectored Instruction, and after a time emerges right back where he or she left off in the curriculum, but now empowered to continue making forward progress.

Improving Memorization with Cognitive Thinking

Memorizing important information is critical to advancing to more difficult concepts. Examples include math facts and physics equations. Beginning readers need to memorize common words because the time needed to sound out words phonetically often degrades comprehension.

Brain imaging studies reveal that when information is repeatedly recalled, the brain eventually re-maps the memory by creating a shortcut. The desired state is

long-term memory or instant recall. Traditional memorization techniques have their pros and cons for creating long-term memories.

Repetition

The traditional memorization technique is to set aside time every day for students to review the information that needs to be memorized, until eventually the brain re-maps the memory. This "brute force" method is extremely inefficient, doesn't work for some students, and is redundant and monotonous, leading to disengagement. In addition, when the brain is required to repeat the same task over and over again, it eventually falls into a lower state of activity.

Mnemonics

A newer method gaining momentum is creating mnemonics that pair an idea, such as a math fact, with a visual or auditory stimulus that is completely unrelated to the fact. These mnemonics, often humorous, are designed to create a lasting memory. (For example, "Kings play chess on fine green sand" for Kingdom, Phylum, Class, Order, Family, Genus, Species). The use of mnemonics has proven effective, especially for students who are unable to concentrate with the repetition method.

However, at a certain point the brain needs to re-map the memory – and that requires repetition. And sometimes, the lack of relationship between the mnemonic and the fact results in students being unable to recall the fact when the teacher isn't there to provide a hint.

The flaw with both methods – repetition and mnemonics – is that when the information is reviewed each day, it is stored in short-term memory. The brain draws upon short-term memory for the rest of the session, which means that the majority of the repetition cycles aren't exercising the part of the brain that creates long-term memories.

Spaced Repetition

Aristotle is credited with the concept that memory is created by the time lapse between direct experience and recollection.[13] This has spawned interesting studies on algorithms that use "spaced repetition" for memorization. Just as increasing the weight lifted increases muscle strength, increasing the time between reviews

[13] *"...to remember, strictly and properly speaking, is an activity which will not be immanent until the original experience has undergone lapse of time." – Aristotle, On Memory and Reminiscence, ~500 B.C.E.*

– say, from daily, to twice weekly, to weekly – strengthens memories. Students spend less time memorizing – and the time they do spend is more effective.

Like other memorization techniques, spaced repetition also requires brain memory re-mapping – that is, creating a shortcut to the information in the brain.

Skirting Working Memory to Create Long-Term Memories from the Outset

Working memory is the part of short-term memory that processes information and forms thoughts (Sweller 1988, 1989, 1994). It is where most of our thinking occurs, and yet it has very limited capacity. In one of the most highly cited psychology papers, Harvard professor George A. Miller observed that humans can hold an average of seven, plus or minus two, chunks of information in working memory.[14] Presented with more than this many chunks, the brain's ability to absorb new knowledge begins to decline because working memory has reached its capacity. This capacity is referred to as cognitive load. The implication for learning? The more information that students need to store in working memory, the less new information they will understand and retain. Therefore, a student who has not already memorized some of the information referenced in a lesson will have difficulty absorbing new information. This student has exhausted working memory capacity on information that others have already moved into long-term memory.

What if there were a memorization method that could a) keep the brain from falling into a low activity mode (not a good thing in the middle of a learning session) and b) bypass working memory to create long-term memories that do not require conscious thought? This is called *implicit memory*, also known as unconscious or automatic memory. Examples are recalling the words of a song after hearing the first lines, or immediately recalling the product of 12 x 12 without working it out.

Implicit memories having the greatest impact require information to be meaningfully organized. When Dmitri Mendeleev organized the elements into the periodic table, something incredible happened. Not only was the information visually understandable for the first time, but Mendeleev was also able to identify holes: elements that had not been previously discovered. Innovative organization changed chemistry as we know it today.

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[14] "George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," Psychological Review, 1956

Could a similar approach be applied to basic information to facilitate memorization? Consider the most commonly used table of addition math facts, organized by one of the digits in the sum (Figure 2.12). Notice two things: First, all of the math facts appear twice. Does it really help a student to memorize 6 + 4 = 10 as well as 4 + 6 = 10? Second, there is no visual connection between 5 + 5 and 6 + 4. That's a missed opportunity for learning because students form memories the best when they can connect them to existing memories.

Addition table of 1	Addition table of 2	Addition table of 3	Addition table of 4	Addition table of 5
1 + 0 = 1 1 + 1 = 2 1 + 2 = 3 1 + 3 = 4 1 + 4 = 5 1 + 5 = 6 1 + 6 = 7 1 + 7 = 8 1 + 8 = 9 1 + 9 = 10 1 + 10 = 11	2 + 0 = 2 2 + 1 = 3 2 + 2 = 4 2 + 3 = 5 2 + 4 = 6 2 + 5 = 7 2 + 6 = 8 2 + 7 = 9 2 + 8 = 10 2 + 9 = 11 2 + 10 = 12	3 + 0 = 3 3 + 1 = 4 3 + 2 = 5 3 + 3 = 6 3 + 4 = 7 3 + 5 = 8 3 + 6 = 9 3 + 7 = 10 3 + 8 = 11 3 + 9 = 12 3 + 10 = 13	4 + 0 = 4 4 + 1 = 5 4 + 2 = 6 4 + 3 = 7 4 + 4 = 8 4 + 5 = 9 4 + 6 = 10 4 + 7 = 11 4 + 8 = 12 4 + 9 = 13 4 + 10 = 14	5 + 0 = 5 5 + 1 = 6 5 + 2 = 7 5 + 3 = 8 5 + 4 = 9 5 + 5 = 10 5 + 6 = 11 5 + 7 = 12 5 + 8 = 13 5 + 9 = 14 5 + 10 = 15
Addition table of 6	**Addition table of 7**	**Addition table of 8**	**Addition table of 9**	**Addition table of 10**
6 + 0 = 6 6 + 1 = 7 6 + 2 = 8 6 + 3 = 9 6 + 4 = 10 6 + 5 = 11 6 + 6 = 12 6 + 7 = 13 6 + 8 = 14 6 + 9 = 15 6 + 10 = 16	7 + 0 = 7 7 + 1 = 8 7 + 2 = 9 7 + 3 = 10 7 + 4 = 11 7 + 5 = 12 7 + 6 = 13 7 + 7 = 14 7 + 8 = 15 7 + 9 = 16 7 + 10 = 17	8 + 0 = 8 8 + 1 = 9 8 + 2 = 10 8 + 3 = 11 8 + 4 = 12 8 + 5 = 13 8 + 6 = 14 8 + 7 = 15 8 + 8 = 16 8 + 9 = 17 8 + 10 = 18	9 + 0 = 9 9 + 1 = 10 9 + 2 = 11 9 + 3 = 12 9 + 4 = 13 9 + 5 = 14 9 + 6 = 15 9 + 7 = 16 9 + 8 = 17 9 + 9 = 18 9 + 10 = 19	10 + 0 = 10 10 + 1 = 11 10 + 2 = 12 10 + 3 = 13 10 + 4 = 14 10 + 5 = 15 10 + 6 = 16 10 + 7 = 17 10 + 8 = 18 10 + 9 = 19 10 + 10 = 20

Figure 2.12: The Addition Table as traditionally presented forces students to memorize each math fact twice.

Now consider what happens when the facts are grouped by the sum (Figure 2.13). This organization facilitates memorization in two ways: it reduces the number of math facts the student needs to learn and groups facts in subsets that allow subconscious connections to be made – such as between 4 + 6 and 5 + 5. The student can draw upon better-known facts to help recall the less-known facts. This method has been proven effective but is traditionally used only to teach the sums of ten.

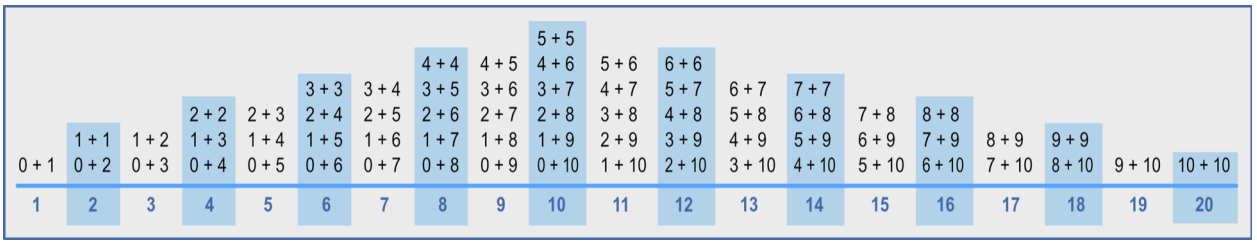

Figure 2.13: The Pyramid of Sums presents each math fact only once and helps students link facts in logical associations.

How Acellus Puts Cognitive Science to Work

Acellus presents lessons in a way that fills up the student's working memory so that the new bits of knowledge go directly into implicit memory. Although the focus of the activity is not the new knowledge, the student needs to repeatedly access the underlying information. This means the information must be organized in a way that doesn't require cognitive thinking to process.

Here's an example. Instead of simply entering answers to math facts, students are assigned to pair numbers that add up to a specified sum (Figure 2.14). After realizing that the sum is the same for the whole session, students can transfer their focus from the math facts to the cognitive task of pairing numbers. The pairing exercise occupies working memory, requiring the search to subconsciously recall the math facts from their implicit memory.

Figure 2.14: Requiring students to focus on pairing numbers instead of on the math sums they must know to do so, the Acellus Math Facts Drill helps them cement these important facts in their implicit memory.

In summary, Acellus continually explores new technologies, applications, research, and techniques to cater to the unique learning needs of every student. Standing on the shoulders of giants in education and innovation, Acellus gathers in the best resources, examines the strengths and shortfalls of new approaches to

education, and then goes outside the box to discover and build solutions that deliver real results.

Chapter 3:
PREPARING STUDENTS FOR LIFE

Meet some of our new students:

- Anna has just arrived in America, unable to understand, speak, read, or write English;
- Jimmy is a struggling student with special learning needs;
- Laura, a gifted and talented student, is trying to decide whether to become a professional oboe player or an anthropologist;
- Bobby keeps to himself, doesn't make friends, and is sometimes disruptive in class.

Sound familiar? Every student has a unique story – a combination of needs, gifts, and dreams. Whatever story a student brings to us, one of our primary directives at Acellus is to prepare that student – and every student – for the challenges and opportunities they will face in life, setting them on course for a successful future.

In this chapter we will explore some of the important ways Acellus prepares students for meaningful and productive lives.

Developing Student Writing Abilities: Acellus Writing Tutor
STEM 10: Connecting Students to STEM Careers
Universal Language Instruction: Discover English
Social and Emotional Learning
Acellus for Students with Special Needs – Success for All Learners
Preparing Students for College
Career and Technical Education

Developing Student Writing Abilities: Acellus Writing Tutor

"Literacy, or the ability to read and write, is one of the greatest gifts you can give a person," says Richard Perkins, a professional writing coach. He goes on to state that this gift opens up opportunities throughout the learner's lifetime and even impacts the next generation.[15]

Indeed, in order for students to be successful in life – in school, in the workplace, in their personal lives, and no matter what their field of pursuit -- they must learn to write well. Learning to write develops logical reasoning skills, communication skills, creative thinking, and creativity[16] – all important traits for success.

However, one of the most difficult challenges in education – and especially in distance learning – is helping students to become effective writers. This struggle is reflected in a recent report of National Rankings of ACT scores from September, 2021 and later, in which none of the students achieved a score higher than 12 out of a possible 36 on the writing portion of the exam.[17]

Clearly, something needs to change.

It has been said that the most effective way to teach writing is to get students to write – and write – and write! This is true, but with one important, additional step: a feedback loop. Students need to be provided with feedback on how they can improve their writing, then write some more, then get more feedback, and so on. Unfortunately, this requires intensive teacher supervision and grading.

A tool has long been sought which would provide an interactive, real-time writing experience as though a full-time teacher was present to tutor the student, providing feedback step by step. Such a tool would give students the ability to write more and would give teachers the ability to focus on the specific parts of teaching writing that only a teacher can do.

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[15] How to Teach Writing Skills, Richard Perkins, WikiHow, https://www.wikihow.com/Teach-Writing-Skills, December 2, 2021.

[16] Why Is Writing Important in Life? https://www.reference.com/world-view/writing-important-life-9708886692edc570, March 25, 2020.

[17] ACT Scores: National Ranks, https://www.act.org/content/act/en/products-and-services/the-act/scores/national-ranks.html

The Acellus Writing Tutor is designed to be that tool – to "tutor" students as they write (see Figure 3.1). This tool provides feedback to teach grammar, spelling, vocabulary, and writing style. Through real-time feedback on their work before the assignment is turned in, it offers the learning experience where it matters most – in the student's own writing.

Here's how it works:

A student is given a writing assignment. Using the Writing Tutor, she works right on the computer. When the she finishes the assignment, she submits it.

Figure 3.1: In the Writing Tutor, students are given feedback on their writing before they submit the assignment for grading, as well as after submission to help them boost their score.

This is where the learning begins.

Before accepting the assignment, the Writing Tutor analyzes the student's composition. It checks whether she has achieved the requirements of the assignment – usually including a minimum number of words and the use of key words specified in the instructions. It flags spelling, grammar and punctuation errors. All requirements must be met and all errors corrected before the assignment will be accepted.

While the Writing Tutor does highlight spelling errors, it does not rob the students of the opportunity to learn. Instead of allowing students to fix the errors automatically with just a mouse-click, Writing Tutor provides a built-in dictionary and requires students to look up and manually correct the misspelled words. In addition, it provides mouse-over tips for grammar and punctuation errors, which are also highlighted, and requires students to correct these errors, as well.

When the text is completely error free, the student again submits the assignment. This time, a percentage score is presented, based on the grade-level and complexity of the writing. Next to this score students see a "Boost Score" button that they can use to access further feedback on their writing.

Designed to help students write on grade level, "Boost" suggestions are presented in three categories: vocabulary, style, and structure.

- VOCABULARY - provides academic word ideas, as well as commonly-used words that could be replaced with more effective synonyms.
- STYLE - rates students' writing in two areas:
  - Tone is rated on a scale from conversational to formal.
  - Sentiment is rated on a scale from negative to positive.
- STRUCTURE - suggests transitional phrases to help provide structural flow, as well as tips to improve sentence length.

For each category, the student is shown the number of points she's been docked. With this tool, Acellus Writing Tutor now helps the student improve her writing style and complexity, displaying how her score increases with each improvement. Using the Boost Score options, students can raise their writing above grade level and achieve scores in excess of 100% (see Figure 3.2).

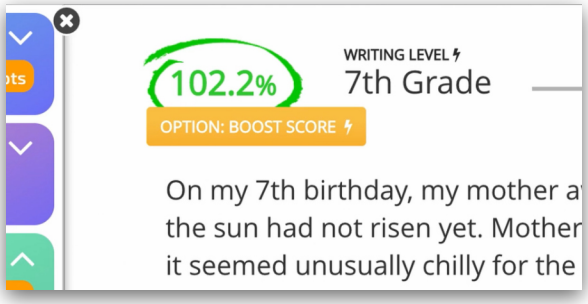

Figure 3.2: The Boost Score option gives students the ability to earn scores higher than 100%.

When the student is satisfied with her score, she selects the Final Submission button to complete the assignment. But the Writing Tutor does one more analysis: it has a built-in plagiarism checker to ensure that students understand the importance of doing original work.

The Writing Tutor can also be used to teach grammar and punctuation when a teacher requires students to find and correct errors within a preset text. This allows teachers to assess the students' understanding of specific deficiencies that may not typically be apparent in their own work.

Writing Tutor helps students improve their writing abilities – whether the subject is English, Social Studies, or even Science. It does this by doing the following:

- It identifies each student's grammar, spelling, and writing issues.
- It offers detailed, consistent feedback.
- It expands on the writing assignment to help students improve their writing and even write above grade level.

The Writing Tutor makes each student feel that she can be an exceptional writer. It is an effective tool of instruction for all subjects. With the Writing Tutor, Acellus is helping thousands of students learn to write well.

Connecting Students to STEM Careers

Technology is becoming more and more pervasive in our lives, and it is becoming increasingly useful for us to understand how the technology around us works. Indeed, coding literacy is quickly becoming a necessary career skill. Not only is the number of available jobs increasing faster in technology fields than in others[18] – it is estimated that nearly 3.5 million STEM jobs will need to be filled by 2025[19] – but more than half of the programming jobs that are available are in non-technical fields.[20]

In addition, while it is important that sufficient young people be prepared for the tech jobs that need to be filled – in whatever field they exist – there are other reasons to teach coding in our schools: learning coding also provides students with skills such as creative problem solving, logical thinking, self-management, mental flexibility, and the ability to quickly source reliable information[21] – all skills that are increasingly in demand, no matter what careers students choose.

Furthermore, the earlier we begin to teach students to code, the greater the level of coding literacy they can have when they emerge into college or the workplace.

The fact that very few elementary school teachers have been trained to teach coding has not eluded the attention of the Acellus team. Along with the need for today's students to learn coding, this is a problem we are actively and passionately addressing.

The Acellus STEM-10 Program

Acellus provides a way to help schools provide students with coding literacy, whether or not there is a coding-qualified teacher on staff: The Acellus STEM-10 Program.

Acellus STEM-10 is a major initiative engineered to significantly increase the number of students prepared for high-tech careers right out of high school. STEM-10 is

[18] Employment in STEM Occupations, U.S. Bureau of Labor Statistics, April 19, 2022, https://www.bls.gov/emp/tables/stem-employment.htm
[19] The State of STEM Education Told Thru 22 Stats, Ryan Barone, Blog & News, iD Tech, May 20, 2022, https://www.idtech.com/blog/stem-education-statistics
[20] State of the Workforce, CompTIA, March 2022, https://www.cyberstates.org/pdf/CompTIA_Cyberstates_2022.pdf
[21] Do Your Kids Need to Learn to Code? Yes! But Not for the Reasons You Think, Grant Hosford, The Blog, HuffPost, May 29, 2016, https://www.huffpost.com/entry/do-your-kids-need-to-lear_b_7473058.

a cohesive 10-year program starting in elementary school. The first seven years of the program focus on STEM instruction, starting with coding in the third grade and adding complexity each year. In the 10th grade, students branch into a specific STEM pathway that matches their interest (see Figure 3.3). The Acellus STEM-10 program prepares students for our technological future.

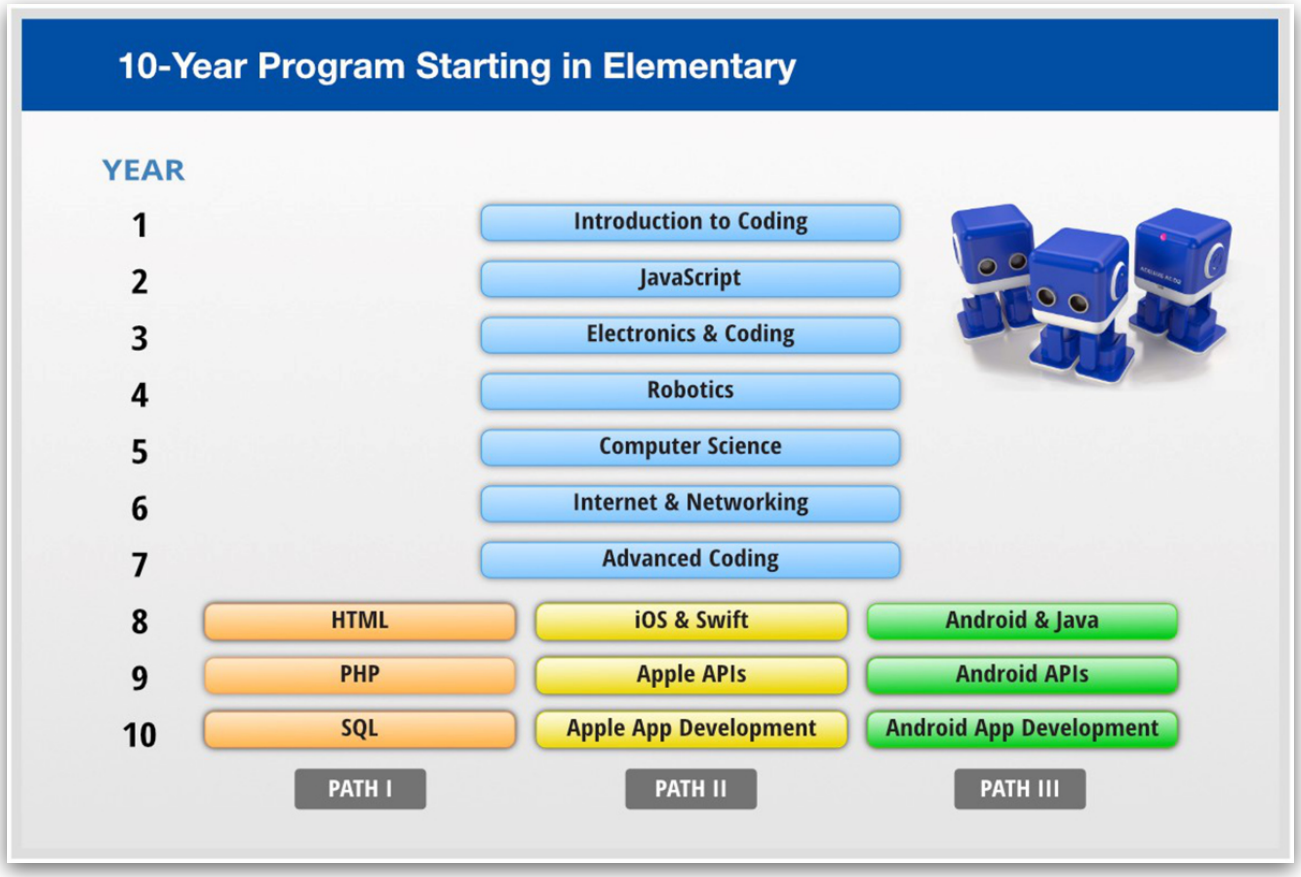

Figure 3.3: Designed to begin in Grade 3, the Acellus STEM-10 Initiative prepares students to fill programming jobs or to go on to college studies in STEM fields upon graduation from high school.

Direct, Self-Contained Instruction

The Acellus coding instruction is self-contained and delivered through the Acellus system, enabling schools to implement STEM-10 in classrooms where a STEM-trained teacher is not available. The coding courseware is video-based and adaptive to the students' individual needs, allowing schools to personalize the STEM instruction to the level and skill set of each learner.

The Acellus STEM Lab program empowers math and science teachers to offer effective coding and robotics courses without the need for extensive additional training. The STEM Lab includes video-based coding courseware and a programmable robot. For students who do not have access to an Acellus STEM Lab, a virtual robot is included in the course for every student. By combining self-contained instruction with interactive tutoring of the student by the robot, Acellus is able to provide schools with STEM courses that can be up and running overnight.

STEM-1: Introduction to Coding

In the first year of STEM-10, students take lessons starting from square zero and then advance step-by-step through the fundamentals of coding. In the first half of the year, the course builds a baseline understanding of the concepts needed to learn coding.

In the second half of the year, the students are introduced to Cellus Bot (see Figure 3.4), a teaching robot equipped with lights, motor, and sensors, all controlled by block coding modules included as part of the course. In addition, the Bot is equipped with a laser and uses it to draw various shapes as it dances. A built-in accelerometer supports program-controlled responses to movements and positioning of the Bot. Students first learn how to control the robot in the simplest manner, but the lessons develop in complexity as the course progresses.

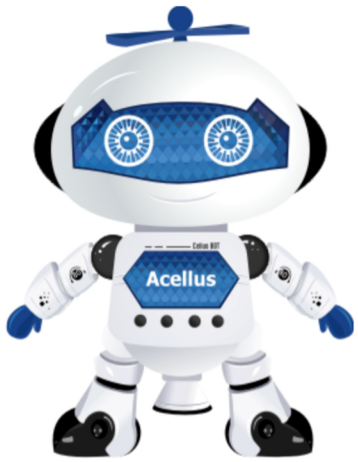

Figure 3.4: Students can program Cellus BOT to dance, to light up – even to speak. It's like having a friend to help them learn.

STEM-2: JavaScript

In the second year of STEM-10, students are introduced to a sophisticated, dancing robot called AC-D2 (see Figure 3.5). Equipped with lights, ultrasound sensors, and multiple motors, AC-D2 can sway, twist, and dance with approximately 10,000 possible step combinations, giving students the opportunity to express their personal creativity.

Students learn to program this more advanced robot through the Level 2 Acellus coding course, which teaches students the syntax needed to program in JavaScript. This allows students to engage in serious coding tasks that will control the robot's personality and movements.

Figure 3.5: The AC-D2 robot gives students a virtually limitless opportunity for creativity as they learn to program their new friend.

STEM-3: Electronics & Coding

Electronics is one of the foundational technologies enabling our modern world. This course shows how electricity is used to make computers and robotics possible. Students learn about concepts like voltage, current, resistance, and capacitance. They also practice JavaScript skills they learned in the previous STEM course. Studies culminate in combining the electronics and coding concepts in ways that show how they are used together in the real world.

Acellus STEM Robotics Lab

A learning environment designed to spark creativity, the Acellus STEM Robotics Lab creates an environment tuned to give students a discover-and-create learning experience. Rather than only working through a simulated environment, Acellus STEM Labs provide students with an actual robot to program.

The specially designed STEM Learning pods include tools intended to spark students' creativity and productivity (see Figure 3.6). Each pod seats three students and contains touchscreen laptop computers, programmable robots, active learning stools, a whiteboard tabletop, and dry erase markers.

Figure 3.6: Acellus STEM Labs are designed to make STEM instruction enjoyable – and effective. Even the table-top helps – it is a white board surface where students can make notes as they work. In the lab pictured above, an AC-D2 robot awaits the opportunity to help a student develop her coding skills.

The Acellus STEM Lab utilizes cognitive instruction, a method of instruction that achieves student learning through the process of acquiring knowledge and understanding through thought, experience, and the senses.

Universal Language Instruction: Discover English

Students of all language backgrounds are filling our schools in greater numbers. Nearly one in four students in public schools across the United States are from an immigrant household, and almost one in five students in the country speak a language other than English at home.[22] These statistics raise profound questions about assimilation. Immigrant students are often disadvantaged and handicapped in their ability to learn because they do not speak English (see Figure 3.7).

With the influx of so many immigrants, schools across America are being forced to make major adjustments to traditional education. First of all, schools need to manage large numbers of students who have had little exposure to education. At the same time, they must find a way to teach many students who do not speak or read English.

Essentially, schools have been mandated to deal with the problem without being given the resources to do so effectively. There are not adequate funds available to employ language specialists, and few teachers are trained to teach in multiple languages. Hiring one-on-one tutors for each student is not only cost prohibitive, but with many students who are not even proficient in their own language, this technique would be ineffective.

Immigrant students are more expensive to educate than non-immigrants, but the federal government supplies little money to support new programs, which means schools are forced to pull required funding from already tight state and local budgets to cover the additional costs. The worst part is that despite all the money that is being spent, there is little to show for it. ESL students are struggling and falling far behind their peers. These students consistently demonstrate dismal progress in all subject areas, and the fallout is negatively affecting the performance of other students as well.

In addition, with the recent increases in virtual learning, many of these students remain in homes where no English is spoken, yet they must learn English in order to be successful in their new country.

[22] *Camarota, Steven. "The Consequences of Immigration for America's Public Schools." The Daily Signal. March 23, 2017.*

Though radical changes in education are required, resources are already being stretched to the limit. A personalized, affordable solution to this education crisis is essential to the future success of our students.[23]

The Goals of Discover English

Discover English was created with the following goals in mind:

1. Empower students to succeed in school and in the work force. Studies have shown that a strong foundation of language allows students to excel in learning. With such a foundation of English, students can succeed in grade-level classes and will be prepared to contribute to the workforce upon leaving school.

2. Help schools succeed by enabling them to offer an ESL program they can actually afford while allowing overworked teachers to go back to teaching regular, important grade-level concepts.

3. Give people the power to communicate and resolve problems. A common language not only enables people to resolve differences through clear communication, but also fuels discussions, which develop into solutions for society's issues.

Discover English – Education Approach

Throughout history, young children have acquired language by being immersed in it – simply by listening, watching, and practicing. Initially, they learn to hear and recognize the sounds of the language. They comprehend meanings long before they can reproduce the words that they understand. As they develop their mouth muscles and fine-tune their ability to hear the language, they begin to identify common word parts before finally hearing individual sounds.[24] With practice and feedback, they fine-tune their speech skills and learn to read "labels" for the words that they already understand.[25]

Discover English is modeled on the way young children learn – by full immersion in the English language. Just as young children start by learning the common sounds

[23] Daly, Christopher J. "THE IMPACT OF IMMIGRANT CHILDREN ON AMERICA'S PUBLIC SCHOOLS." NPG. org. 2018.
[24] Fry, Dennis (1977). "Homo loquens, Man as a talking animal." Cambridge University Press. pp. 107–108. ISBN 978-0-521-29239-9.
[25] Moerk, E.L. (1994). "Corrections in first language acquisition: Theoretical controversies and factual evidence". International Journal of Psycholinguistics. 10: 33–58. Archived from the original on 2019-08-29. Retrieved 2019-08-29.

of the language before they are ready to speak, Discover English starts by exposing students to the common words and sounds of the language, so they can learn to hear and differentiate the sounds. However, although young children have to learn that words have meaning, ESL students already understand that concept and can skip that step. Instead, students just need to learn the English labels for things that they are already familiar with.

Most language programs use a direct-translation method to quickly build vocabulary, but direct-translation only works for simple words and concepts. It limits how deeply a student understands the language and requires a translation step in the language process.[26] This also means that a different language program is required for each native language represented in a student body. With at least 350 languages currently spoken in homes across the U.S., the number of language programs required at one school can quickly become overwhelming.

To reach students of all languages, Discover English uses full-immersion, allowing students to learn concepts like grammar subconsciously. This technique requires students to connect pictures and concepts to words in the English language, which allows students to more easily connect ideas and build on previously-learned concepts (see Figure 3.8). Unlike the direct-translation method, the full-immersion process is geared to students from any background language.

In addition, Discover English addresses the needs of all learning types: visual learners can learn with pictures and visual cues; auditory learners can learn through audio that reinforces concepts shown visually; intrapersonal learners can learn with written text that reinforces concepts shown visually; and kinesthetic learners can learn as ideas are connected through questioning and real-world scenarios.

During the first part of the course, students learn to hear the sounds of the language. With a focus on useful words that will allow students to excel at home, at school, and on the job, Discover English quickly builds a base of over 500 vocabulary words. The most important and most commonly used words – primarily nouns – are presented first, but verbs and adjectives – including colors, feelings, actions, numerals, money, and time – are also included.

[26] VESSELINOV, ROUMEN (December 2012). "Duolingo Effectiveness Study" (PDF). Duolingo.com. Retrieved 30 May 2018.

In order to learn a word well, students need multiple exposures to it. Discover English presents vocabulary words in multiple ways, including video presentations, problem solving, readings, drills, and real-life scenarios. As the course progresses, the time between exposures is increased, pushing the knowledge into long-term memory. Throughout the course, students have at least 12 instructional encounters with each target word to ensure word mastery.[27]

While students are gaining exposure to the language and developing picture-to-word vocabulary, they experience common conversations with visual cues that allow them to understand the discussion without translation. New words are taught by questioning, which prepares a place for students to store the knowledge and connect ideas. Instead of simply matching pictures to words, students learn to answer questions preparing them for "real world" scenarios and exams, and helping them learn how to ask questions of their own. Answering questions requires a deeper level of understanding, which also leads to longer memory retention.[28]

Through sorting and categorizing vocabulary words in multiple ways, Discover English allows students to have more exposures without becoming repetitious or monotonous. It also builds a deeper understanding and connection between words, which forces students to think "outside the box" of the initial meanings.

During the second part of the course, students move from learning to hear the sounds of English to actually speaking and reading the language. Building on the original vocabulary words from earlier in the course, students stretch their understanding of word usage in multiple scenarios and learn sentence structure through repeated readings with variations. Visual cues allow students to connect ideas without direct translations.[29] Students learn subconsciously how to read first person, second person, and third person along with grammar rules like capital letters and ending punctuation. They also learn how to read possessives, plurals, and "to be" verbs.

Students continue to practice vocabulary words while moving through a series of lessons that use different sentence structures. Students see and hear correct lan-

[27] Lawrence, Joshua F, et al. "The Words Students Need." ASCD Publications. Educational Leadership - Interventions That Work, Volume 68, Number 2: 23-26. October 2010.
[28] Wozniak, Dr. Piotr. "Effective Learning: 20 rules of formulating knowledge." Super Memo Articles. February 1999.
[29] Paul, Annie M. "Remember More Without Trying." TIME - Health and Science. August 2012.

guage patterns, allowing them to learn how to speak and write correctly without focusing on the rules of the language, while developing problem-solving skills that prepare students for "real world" situations.

Assessing Language Skills

As students gain confidence in their understanding of the language, Discover English uses voice recognition to help students to "fine tune" and develop their pronunciation of words. Students are allowed to choose more or less practice as needed, with scores enabling them to see their progress in speech mastery.

Decoding scrambled words develops spelling skills while reinforcing meaning (see Figure 3.7). During the spelling drills, students are only given picture clues, forcing them to think deeper as they remember words. A scrambled version of each word keeps students from getting "stuck" while spelling. In drills, students are required to type the words, which aids in memorization, and typed words are followed by auditory reinforcement. These drills develop spelling skills while breaking up the monotony by reinforcing knowledge in a different way.

Throughout the course, Discover English prepares students to take part in conversations by using common phrases in multiple variations. In the second part of the course, students start by completing conversations with single words. As the course develops, they are required to choose the most appropriate response in a conversation. A variation of responses equips students with multiple conversation options. Along with the words of conversations, students learn social cues and proper manners subconsciously while watching interactions between real people.

Through Acellus, the Discover English course brings personalized instruction to students from all backgrounds and offers a realistic option to schools, making it possible for ESL students to become successful.

Figure 3.7: Spelling drills help students learn to read and spell English. Students are given a scrambled word to decode so they are never "stuck" not knowing where to start.

Social Development

Today's educators are tasked with the responsibility of engaging students in learning and helping them perform academically, while also creating an environment of positive thoughts and behaviors. The need for emotional and social education has never been greater, and much of the responsibility falls on educators to teach these important principles. Research shows that social and emotional learning improves student achievement by an average of 11 percentile points, and also significantly improves student attitudes and behavior, while reducing depression and stress.[30] Along with their need for social development and emotional well being, students need to build healthy living habits that will have long-lasting impacts on their happiness and well-being.

Figure 3.8: Social development and emotional well-being are critical areas that students need help with in order to become responsible, happy, contributing members of society.

Acellus has become involved in the mission of providing schools with effective courseware that covers these important, yet sometimes difficult topics.

The Acellus Social Development courses focus on the basic social and emotional concepts that every child needs – from getting along with others to self-esteem, from learning to be aware of the feelings of others to dealing with insensitive people and emotionally challenging situations (see Figure 3.8). The Acellus SEL courses take on important issues in students' lives, helping them cultivate healthy relationships and a caring attitude, along with discovering the value of one's overall well-being and physical health.

[30] *The Impact of Enhancing Students' Social and Emotional Learning: A Meta-Analysis of School-Based Universal Interventions, Durlak et. al. , Child Development, January/February 2011, Vol. 82, Number 1, pages 405-432, https://www.scribd.com/document/346053685/Durlak-Et-Al-2011-Meta-Analysis-SEL.*

Acellus SEL inspires positivity, which will empower students to face the day-to-day challenges they will encounter in the real world. Separate courses have been developed for the elementary, middle, and high school levels.

Crisis Intervention Lessons

When a student is faced with a crisis, timely and targeted intervention is critical. Acellus has developed customized Crisis Intervention Lessons that focus on specific challenging issues, such as divorce, the death of a loved one, bullying, natural disasters, and many more. The appropriate lessons can be selected by the student, or prescribed by a teacher or parent. When a Crisis Intervention lesson is assigned to a student, a companion lesson for parents is also provided via the Parent Interface, along with one for teachers.

SEL Course Instructor

Acellus Social Development courses are taught by Dr. Pajet Monet, whose sincerely caring attitude radiates out to students, helping them to openly consider the life-enriching ideas she presents (see Figure 3.9).

Addressing serious issues that students will encounter throughout their lives, Dr. Monet encourages students to realize that even at a young age, they are the captains of their fates, that they control where their lives will go, and that they have the power to overcome any adversity and become truly amazing people. She further empowers them with simple and effective tools, and shows them how to use them to becoming the people they truly want to be. Students learn from her example as well as from her words.

Figure 3.9: Taught by Dr. Pajet Monet, Acellus' Social Development courses are designed to help students develop healthy attitudes and relationship skills that will empower them throughout their lives.

Acellus for Students with Special Needs – Success for All Learners

Research shows that students with disabilities can make progress toward grade-level standards when they receive high-quality instruction and are assessed with alternate assessments based on modified achievement standards.[31]

The International Academy of Science has spent years researching how to help Special Needs students achieve their full potential in education. This research has included discovering how students in special education programs learn best, and developing the methodology to most effectively reach these learners. As a result, courses have been developed specifically to be achievable by Special Needs Students, while still incorporating the rigor required for standards compliance.

Beginning with standards-based courses, scientist-educators at the International Academy of Science review and modify these courses to include only essential content for each subject. The courses are modified again to teach the content in greater depth and with more appropriate explanation for these students. With content taught at a deeper level, students are allowed to spend more time on each concept, increasing the students' depth of knowledge on each topic. Once analyzed and modified in this way, courses provide multi-sensory instruction, custom designed for students with special needs, and are classroom-tested to be effective in getting students back on grade level. They are then given the "SEd" or "Special Education" designation.

Figure 3.10: Students with special needs are able to excel, often meeting grade-level expectations, when the content is presented in a way that meets their needs.

Beyond this, Acellus is an ideal tool to differentiate instruction for students in Special Education programs (see Figure 3.10). Acellus classes are broken into small concepts, and each concept is taught via video instruction. Each video is short and concise, and is designed

[31] *https://nceo.umn.edu/docs/OnlinePubs/Martha_Thurlow-Meeting_the_Needs_of_Special_Education_Students.pdf*

to convey just one concept. After the instruction, the student is given an assessment designed to determine her mastery of the concept presented. If the student shows mastery on that topic, she is moved forward to the next lesson. However, if additional help is required, another video is delivered automatically, targeting the deficiency in the student's understanding. In this way, Acellus adapts each course for each student, making success attainable.

Incorporating Acellus into programs designed for learners with special needs has dramatically changed the educational experience for both students and educators. Acellus gives educators a powerful arsenal of tools they can rely upon to more truly engage students, cater content to their need and academic skill level, and empower them to achieve their educational goals.

Schools that have incorporated Acellus into their Special Education programs have found that students with special needs are very quickly able to start experiencing success, and are often able to achieve grade-level expectations.

Administrators at some schools have reported that even students who are not within the Special Needs categorization perform better on year-end state assessments after taking these courses.

Acellus can be easily incorporated into IEPs for those students classified as Special Education students under the Individuals with Disabilities Education Act (IDEA). Acellus incorporates Prism Diagnostics® and Customized Personal Instruction (CPI) to meet the unique educational needs of students with disabilities and to help them develop to their maximum potential.

When learning occurs on-site, schools using Acellus courses for Special Education programs typically deploy Acellus in computer labs or mobile laptop labs, where each student has a dedicated computer console from which to operate the Acellus program.

Real-world Success

In an effort to fill a void they noticed in their Special Education program, Alhambra Unified School District (AUSD) in California contacted other schools in their state to find out what was actually working. The unanimous recommendation was Acellus, which worked better, they were told, than multiple other available programs. They decided to try it.

Figure 3.11: Kevin Hardy, a special education teacher at AUSD's Mark Keppel High School, said that using Acellus has empowered him to help students succeed.

After using Acellus for some time, Kevin Hardy, a special education teacher at AUSD's Mark Keppel High School, said that Acellus has allowed him to accommodate the diversity in Special Education (see Figure 3.11). Kevin primarily teaches seniors, many of whom have "gaps" needing to be filled. He said that Acellus empowers him to assign whatever course is needed for an individual student, and to monitor that student's work in addition to his own regular work load. At the beginning of one recent school year, Kevin had ten students who each had ten different classes to make up. Using Acellus, he was able to enroll the students in all of the needed classes – and monitor, keep track of, and help them. All ten students got caught up.

Acellus Tuned Learning Courses

Acellus Special Education courses have proved so successful in schools that administrators have approached us asking that we remove the SEd designation so that they can use the courses for students who do not have an IEP. (See Figure 3.12.)

Figure 3.12: Acellus Tuned Learning Courses help students who, while not Special Needs students, may need a little extra help.

Instead, we created Tuned Learning Courses, designated by TLC after the course name. For these courses, we began with the full-blown version of the course and applied many of the same principles of teaching that we used for SEd courses. Thus we meet the administrators in the middle and provide courses that are more effective for students who, while not special needs students, do need a little more help. From the reports that have come back to us, TLC is working well. All of these courses are slow/normal/accelerated-mode ready, making differentiation fairly simple.

Acellus STEM for Special Education and Autism

Studies show that a higher percentage of students classified with special needs transition into STEM-related careers, compared to other students. Integrating Acellus STEM Robotics Labs into the special education environment allows educators to prepare classified students to be college- or career-ready.

The Acellus STEM Robotics Lab (see Figure 3.13) is optimized to cater to exceptional learners, especially those classified with Autism Spectrum Disorder (ASD). A recent study of students with ASD who attend college, found that 34% chose a STEM-related career – as opposed to less than 23% of their college peers.[32] This, coupled with estimates that the number of STEM-related jobs is increasing, magnifies the importance of preparing students with special needs to transition into college/careers propelling them toward success in STEM related fields.

Not only do students with special needs gravitate towards STEM careers, but the career opportunities in STEM fields, such as computer science, have exploded over the past few years, and it is anticipated that the demand will grow over the next decade. [33]

Figure 3.13: Special needs students seem to excel in STEM careers. STEM can even open a pathway to independence for many students who otherwise would have more limited opportunities.

[32] How Special Needs Students Can Benefit From STEM Education, Cathleen Chen, Christian Science Monitor, February 9, 2016, https://www.csmonitor.com/USA/Education/2016/0209/How-special-needs-students-can-benefit-from-STEM-education
[33] Employment in STEM Occupations, U.S. Bureau of Labor Statistics, April 19, 2022, https://www.bls.gov/emp/tables/stem-employment.htm

Preparing Students for College

College readiness is more than just graduating from high school and deciding which college to attend. Many students need help discovering what interests them and what they are good at so that they can make a plan for their future (see Figure 3.14). The wide selection of courses offered by Acellus enables schools to offer a well-rounded education to students in preparation for the careers of the future.

Figure 3.14: High School students have a lot to prepare for, and a lot of decisions to make – such as what career to pursue, and how to achieve it. Acellus provides courses to help with decisions and plans for the future.

Advanced Placement

Acellus provides the core courses needed for graduation, but also many honors and College-Board-approved Advanced Placement (AP) courses that can give students an advantage when starting college.

Acellus' AP courses allow students to gain college credit while still in High School. Thousands of colleges and universities across the nation and internationally recognize AP courses, and will grant college credit to students with exam scores of 4 or 5 (AP exams are scored from 1 to 5). Many colleges also consider AP credit in the admissions process and when considering placement. Students with outstanding AP scores often have the opportunity to move into upper-level courses sooner, pursue a double-major, or study abroad.

Because of the extensive and varied catalog of Acellus AP courses offered, students who apply themselves can complete most or all of the general education college requirements while still in high school. This gives students advancement opportunities that wouldn't otherwise be possible, and enables them to spend more of their college time on courses that move them closer to their career goals.

Acellus AP courses are taught by certified AP Instructors who have years of experience teaching AP material, and preparing students to be ready for the rigorous AP exams. These courses follow a rigorous curriculum specified by College Board.

Courses are taught via video instruction, and combined with adaptive and interactive assessments on each concept. The lessons are automatically graded, and the course is literally tailored to each student's level and need. Students desiring college credit for AP courses will need to pass the AP exam administered at an authorized testing site.

Career and Technical Education

Acellus Career and Technical Education (CTE) courses incorporate the necessary academic anchor standards and the career and life-skills training that are essential for success in the "real world." With the various career clusters Acellus offers, students can invest in their future by taking courses specific to the career pathway of their choice. In addition, high school graduation rates have been shown to be significantly higher when students are enrolled in CTE programs.[33]

Acellus CTE courses provide career-related education, while also taking the experience a major step further by preparing students to earn Industry Certifications. These industry-recognized credentials are extremely valuable. They provide assurance to employers that applicants are work-ready on day one.

CTE 100 – Courses in 100 Career Pathways

To help students prepare for their careers, the International Academy of Science has created the CTE-100 Initiative, which involves the development of courses for a hundred different career pathways. For each of these careers, two full-year courses are being created. We have already made substantial progress in the fulfillment this initiative, offering over 25 career courses, including heating and air-conditioning, electrical technology, and plumbing, among others (see below). The curricula for these courses follow state CTE guidelines, but also align with relevant industry standards so that students will be qualified, upon successful completion, to take industry-recognized certification exams. This will open the way for them to move into entry-level positions in these fields, right out of high school.

Chapter 4:
DEVELOPING ACELLUS COURSEWARE: PRESENTATION OF INFORMATION

Acellus Course Overview
Creating an Acellus Course
Generate the Lesson List
Prepare Lesson Content, Following the Acellus Teaching Model
Film the Video Lesson
- Developing Acellus Video Lessons
- Developing Acellus Help Videos

Add Acellus Special Lessons for Blended/Hybrid Learning Environments
Write Acellus Lesson Manuals
- Acellus Lesson Manual Format

Use the Acellus CybrEducation Program to assemble the course syllabus, assignments, lesson manuals, and videos into a complete course. Chapters 4 and 5 provide guidelines and best practices for creating an Acellus course, from filming engaging videos to writing meaningful assessments and lesson manuals. In this chapter we will focus on the presentation of information – lesson videos, help videos, special lessons, and lesson manuals.

Acellus Course Overview

As described in the chapters above, Acellus applies science to the process of education, and Acellus courses are designed to be improved over time as a result of the application of the scientific method.

At the time of their debut, Acellus courses are composed, at the minimum, of a series of lessons (which include formative assessments) and a series of summative assessments (which include Unit Exams, a Mid-term Exam, and a Final Exam).

A lesson is a group of activities – or steps – that are all designed to help the student gain mastery of a specific concept. Typical lessons consist of a video instruction step followed by an assessment step. Lessons can also include drills, which help students memorize important facts and details associated with some concepts, as well as short eBooks. Each of these activities is referred to as a step.

Each lesson has a clearly defined learning objective. A l*earning objective* is a statement of the specific and measurable knowledge and skills students will be able to achieve and demonstrate as a result of completing the lesson.

Acellus courses include unit, mid-term, and final exams. Exams consist of random assessment items taken from each lesson but selected to be different and unique from the specific assessment items the students were exposed to during the lessons. In preparation for each exam, students are given a review which prepares them for the exam while also helping ingrain the lesson content into long-term memory. Although they are not part of any lesson, reviews and exams are also referred to as steps.

Finally, there are two additional items that are associated with lessons:

- Special Lessons – onsite or homework assignments that help students develop and improve important skills that are not currently addressed through the online lessons

- Lesson Manuals, which present the lesson material in a written format, often with illustrations

Creating an Acellus Course

Acellus courses are created through the following steps:

1. Generate the lesson list.
2. Prepare course content following the Acellus Teaching Model.
3. Film the Video Lessons.
4. Prepare Assessments
5. Prepare Special Lessons, Lesson Manuals, and Drills.

In this chapter we will discuss the first three items, as well as preparing Lesson Manuals and Special Lessons – the items concerned with presenting information to the students.

Step 1 – Generate the Lesson List

The first task in creating an Acellus course is to build the lesson list. The lesson list should consist of two items for each step:

- a concise title for each lesson
- a statement of the associated learning objective

When naming a lesson, it is important to keep in mind the following ideas:

A video should be associated with each lesson concept to be assessed. Lesson video content will often be broad – addressing several closely-related concepts required to satisfy relevant standards. However, even though the video may cover multiple concepts, the focal point of the lesson should rest upon the key concept the student is responsible to master. This key concept should be something that is important for future learning, career, and life. Sample assessment items presented during the video should concentrate on teaching this key concept.

Note: remember – in Acellus, a lesson is defined to be a set of steps that are required for students to achieve a specific learning objective.

The assessment step following the video should be centered on evaluating student understanding of the key lesson concept. All of the assessment items in the set should be parallel, both in their focus and in their level of complexity, so that every student will be provided with a similar learning experience. *In cases where the on-camera teacher wants to assess students on more than one lesson concept, separate lessons should be created and separate videos should be filmed for each.*

Standards-based textbooks serve as excellent references for preparing the lesson list. Limit each lesson to one concept or idea, keeping in mind the video and course length guidelines listed below (see Figure 4.1).

Level	Course Length (Number of Video Lessons)	Normal Lesson Video Length (Minutes)
Elementary School (K-5)	175-180	7
Middle School (6-8)	175-180	10
High School (9-12)	175-180	12
AP	175-180	15

Figure 4.1: Acellus Course and Video Length Guidelines. Although a preferred video length is given, some concepts take much less time to convey. In such circumstances, a lower video length may be used.

When naming a lesson, consideration should be given to the fact that the students will see the title, which should therefore be written in a manner that will prepare them to receive the lesson material. The name should be short and concise. For example, "Significant Digits in Numbers" would be considered a good title, while "Identifying Significant Digits in Numbers" might be too long. It would be better to save the "identifying" verb for part of the learning objective.

The Learning Objective

Writing the learning objective is a most important step and should be done with care and thoughtful consideration. The learning objective is a statement of the specific knowledge and skills that will be taught in the lesson, but it also must include the measurable ability that students will be able to achieve and demonstrate as a result of completing the lesson (see Figure 4.2). Current standards require that learning objectives be written such that the outcome of the lesson and the method of assessment be clearly identified in the learning objective. Since this is new and a little "tricky", we will delve into the matter in more detail.

A good learning objective has the following form:

> "By the end of this lesson, you will be able to [action verb] [target of the action verb]."

The Action Verb

The action verb must be relevant and must tie to the measurable method of assessment which will be used for this lesson. For example, if you are planning to use multiple choice assessments for a particular lesson, then an acceptable action verb would be "identify." On the other hand, the action verb "create" would not fit multiple choice assessments since such assessments could not determine the student's ability to create. In other words, the standard requires that the lesson list anticipate the type of assessment to be used – empowering the on-camera teacher to better prepare students for the assessments to follow.

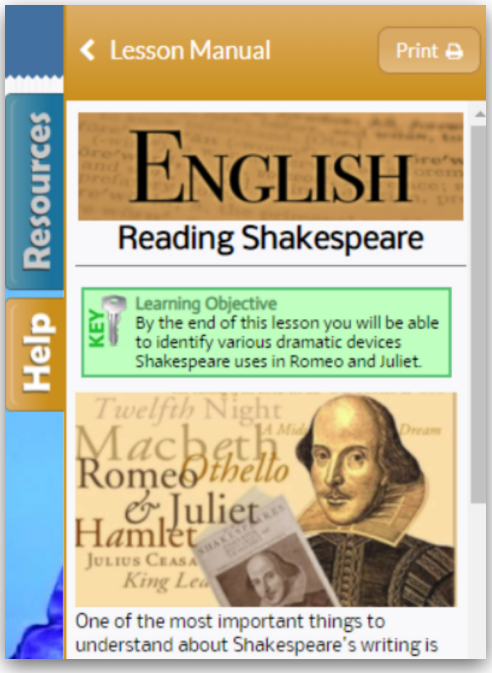

Figure 4.2: The learning objective is displayed to students in the Lesson Manual.

Some verbs are considered non-measurable and should therefore be avoided. Examples of non-measurable verbs include "understand" and "know." It is difficult to prove that students understand or know a specific concept, and for these reasons, reviewers will usually reject the use of such verbs.

The reasoning behind using the words "you will be able" is this: students preparing for this lesson will see the learning objective; knowing the objective, they become more involved in making achieving the goal of understanding and remembering the lesson material.

The Target of the Action Verb

The target of the action verb is the *concept* that students are expected to learn. It answers the question "what will learners be able to [insert action verb here]?" Examples: "what will learners be able to *identify*?" "…be able to *write*?" "…be able to *solve*?" "…be able to *code*?"

The word "target" is used here instead of the word "object" (its English grammar label) to emphasize that through this lesson, students – like a hunter stalking her

prey – will be able to use what she obtains to accomplish something. The hunter would obtain food and use it to feed her family. The student will obtain knowledge and use it to accomplish something no less real, such as to solve a polynomial – or (eventually) to calculate the trajectory of a flight to mars.

The target of the action verb will usually be the focus concept of the lesson, and will usually reflect the name of the lesson.

For example, for the lesson "Significant Digits in Numbers," an appropriate lesson objective might be the following:

"By the end of this lesson, you will be able to identify significant digits in numbers."

Active verb: identify. Target of the active verb (what will students be able to identify?): significant digits in numbers.

Examples of Learning Objectives

Here are some more examples of learning objectives for Acellus lessons:

- **Examples of learning objectives for multiple choice assessment items**
  - By the end of this lesson, you will be able to identify significant digits in a number.
  - By the end of this lesson, you will be able to find the predicate in a sentence.
  - By the end of this lesson, you will be able to choose colors by name.
- **Examples of learning objectives for typed response assessment items**
  - By the end of this lesson, you will be able to compute the sum of two-digit numbers.
  - By the end of this lesson, you will be able to convert between feet and meters.
  - By the end of this lesson, you will be able to solve trinomials using the quadratic formula.
- **Examples of learning objectives for using the Writing Tutor for assessments**
  - By the end of this lesson, you will be able to write a short story on grade level.

  - By the end of this lesson, you will be able to describe Avogadro's number.
  - By the end of this lesson, you will be able to explain DNA replication.
- **Examples of learning objectives for blockly assessment items in STEM courses**
  - By the end of this lesson, you will be able to create and use an array in a JavaScript program.
  - By the end of this lesson, you will be able to properly format and use an if/else conditional statement in JavaScript.
  - By the end of this lesson, you will be able to debug basic JavaScript syntax errors.

In Acellus, assessment-item writers are able to select from multiple templates, depending on the type of assessment item desired. The templates are discussed in more detail later in this chapter and in Chapter 11. However, to assist with the preparation of lesson lists, several assessment item types are listed below, including the assessment-item template name and examples of measurable outcome verb choices. These assessment item types include the following:

- True/False assessment items (see Figure 4.3)
- Typed Response assessment items (see Figure 4.4)
- STEM Course assessment items (see Figure 4.5)
- Multiple Choice assessment items (see Figure 4.6)
- Writing Assignments (see Figure 4.7)

Assessment Item Type – True/False	
Template ▪ 2 Horizontal Image Buttons ▪ 2 Image Buttons ▪ Image with 2 Image Buttons ▪ Image with 2 Long Image Buttons ▪ Image with 2 Text Buttons ▪ Text with 2 Text Buttons ▪ Video with 2 Image Buttons	**Measurable Outcome Verb Choices** ▪ None – True/False assessment items should be avoided in assessment items. They are inadequate for assessing students' depth of knowledge.

Figure 4.3: Assessment Item Templates and Measurable Outcome Verb Choices for True/False assessment items. In general, we do not recommend the use of True/False problems.

Assessment Items Type – Typed Response	
Template ▪ Image with Percent Accuracy ▪ Image with Text Answer	**Measurable Outcome Verb Choices** ▪ Add ▪ Apply ▪ Calculate ▪ Carry Out ▪ Combine ▪ Complete ▪ Compute ▪ Convert ▪ Differentiate (math) ▪ Divide ▪ Equate ▪ Estimate ▪ Evaluate ▪ Expand ▪ Express (math) ▪ Integrate (math) ▪ Multiply ▪ Perform ▪ Practice ▪ Rearrange ▪ Simplify ▪ Solve ▪ Substitute ▪ Subtract ▪ Use ▪ Utilize

Figure 4.4: Assessment Item Templates and Measurable Outcome Verb Choices for Typed Response assessment items

Assessment Items Type – STEM Course	
Template ▪ Blockly ▪ Circuit	**Measurable Outcome Verb Choices** ▪ Calculate ▪ Code ▪ Combine ▪ Comment ▪ Compare ▪ Complete ▪ Create ▪ Debug ▪ Draw ▪ Format ▪ Identify ▪ Implement ▪ Match ▪ Measure ▪ Read ▪ Set ▪ Solve ▪ Use ▪ Wire ▪ Write

Figure 4.5: Assessment Item Templates and Measurable Outcome Verb Choices for STEM course Assignments

Assessment Items Type – Multiple Choice	
Template ▪ 2 Horizontal Image Buttons ▪ 2 Image Buttons ▪ 3 Horizontal Image Buttons ▪ 3 Vertical Image Buttons ▪ 4 Image Buttons ▪ Image with 2 Image Buttons ▪ Image with 2 Long Image Buttons ▪ Image with 2 Text Buttons ▪ Image with 3 Image Buttons ▪ Image with 3 Text Buttons ▪ Image with 4 Long Text Buttons ▪ Image with 4 Text Buttons ▪ Scrolling Text with 3 Text Buttons ▪ Scrolling Text with 4 Text Buttons ▪ Text with 2 Text Buttons ▪ Text with 3 Text Buttons ▪ Text with 4 Image Buttons ▪ Text with 4 Long Text Buttons ▪ Text with 4 Short Text Buttons ▪ Video with 2 Image Buttons ▪ Image with Percent Accuracy ▪ Image with Text Answer	**Measurable Outcome Verb Choices** ▪ Choose ▪ Compare ▪ Complete ▪ Equate ▪ Estimate ▪ Find ▪ Identify ▪ Indicate ▪ Locate ▪ Match ▪ Pick ▪ Recall ▪ Recognize ▪ Relate ▪ Select ▪ Specify ▪ Review

Figure 4.6: Assessment Item Templates and Measurable Outcome Verb Choices for Multiple Choice assessment items

Assessment Items Type – Writing Assignments			
Template ▪ Writing Tutor	**Measurable Outcome Verb Choices** ▪ Compose ▪ Describe ▪ Discuss ▪ Elaborate ▪ Explain	▪ Expound ▪ Express ▪ Give Examples ▪ Report	▪ State ▪ Summarize ▪ Tell ▪ Write

Figure 4.7: Assessment Item Templates and Measurable Outcome Verb Choices for Writing Tutor Assignments

Step 2 – Prepare Lesson Content, Following the Acellus Teaching Model

To create effective, engaging, and empowering lessons, follow the Acellus teaching model shown in Figure 4.8.

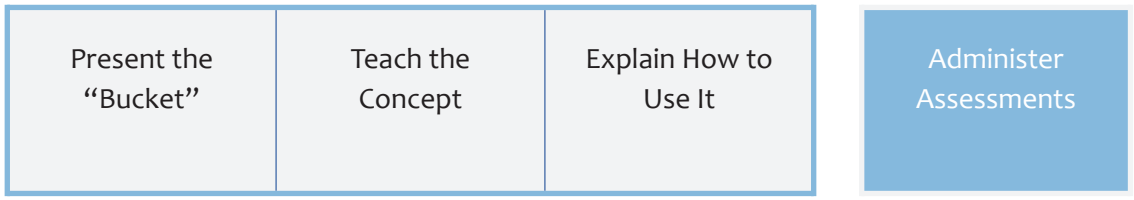

Figure 4.8: The Acellus Teaching Model shows students, before each concept is given to them, where it fits into their universe of knowledge. Next it is taught, how it is used is explained, and their mastery of the concept is assessed.

1. **Present the bucket.**

   Provide context for the lesson. This gives the students a place to put the new knowledge – it helps them understand how the new content hooks on to what they already know, making it relevant.

2. **Teach the concept.**

   Present the nuts and bolts of the concept. Teach all material normally covered in the classroom, focusing on the content required by standards and omitting content that is irrelevant or that could be confusing. After explaining the concept, provide relevant examples that will help students achieve the stated learning objective and prepare them to solve the assessment items they will be assigned after the video.

3. **Explain how to use the knowledge.**

   Help students see how they will be able to use the new knowledge. Some concepts simply provide the foundation to learn other concepts, and students will need to learn several concepts before they can do something with the information. In these cases, explain to students how they will eventually be able to use this information. Example: "This is one of the things that you will need to know to be able to build a rocket."

   In other cases, students will master the content sufficiently to apply this understanding toward achieving higher-cognitive-level learning objectives. In such cases, consider creating a separate video for these more advanced concepts.

4. **Create practice and assessment items.**

   Ideally, assessment items should follow every video. Someone other than the on-camera teacher often writes assessment items. Tips for writing effective assessment items appear in Chapter 5.

Step 3 – Film the Video Lesson

When filming a lesson, think about the target audience to make each video engaging, interesting, and exciting. Students should feel as though the on-camera teacher is right there teaching them. Be sure to keep in mind the focus of each lesson (as stated in the learning objective) and present each lecture as concisely as possible to keep the student's interest.

Developing Acellus Video Lessons

Acellus on-camera teachers have a great deal of leeway when filming video lessons, but should follow these guidelines to maximize course effectiveness.

Figure 4.9: Using multimedia, animations, and audio can add interest as well as clarity to Acellus lessons.

The Do's:

Teach the learning objective of the lesson. Include related ideas in the video if they reinforce the lesson concept. Deliver the instruction students need to master the course material, freely combining lecture, multimedia, animations, and audio (Figure 4.9). Lessons give the on-camera teacher an opportunity to engage students in a concentrated way, creating the feel of a one-on-one learning experience.

When appropriate, create multiple videos to teach the same concept or idea at different levels:

- *Normal Mode* videos are intended for the average learner. They are used as the primary instruction for all students unless additional video content is filmed for other modes.
- *Slow Mode* videos are targeted to students who need a little longer to master the material. These videos often include extra examples and

review material taught in prior lessons to lay the foundation for the current one. Sometimes they cover the content in a more basic manner.
- *Accelerated Mode* videos are targeted for gifted students. They provide more rigorous treatment of the concept, going into the content on a deeper level and providing more advanced details and examples specially focused on challenging these most advanced students.

Make the video as long as necessary to teach the learning objective. Following are guidelines:

- Elementary-level courses: 7 minutes
- Middle school-level courses: 10 minutes
- High school-level courses: 12 minutes
- AP-level courses: 15 minutes

Present lectures in the style that's most effective and natural for you. On-camera teachers have latitude in terms of concepts to cover, the order of concepts, and books and materials used for preparing the lesson content.

Follow any required curriculum standards, as dictated by the Acellus Editorial Board. While the on-camera teacher is considered to be the expert on teaching the material, the Acellus team provides constructive feedback to help make the teaching experience as professional and effective as possible.

Use visuals and demonstrations to enrich the learning experience. Visual enhancements can significantly augment the learning process, enabling students to visualize difficult-to-understand concepts and processes, resulting in improved comprehension and retention. Consider filming in one of the Acellus green screen studios and requesting that relevant background images or special effects be added during postproduction. Alternatively, consider including PowerPoint slides, white boards, or animated text or images added by our editing team after filming. A word of caution: when the lesson progresses very slowly – for example, when a teacher is writing on the board – students tend to get distracted and lose concentration. Consider adding animated writing (which is faster) to the video in postproduction. Feel free to request graphics or animations to enhance a given lesson. Either submit requests to the editing team in writing or state the request in the video before the start of a lesson – for example, "Note to editors: In this lesson I will refer to cities along the Nile River – please display a map of the river and then

highlight the cities as I refer to them." Animated text or images added during post-production can be presented as floating graphics that share the screen with the teacher, or can fill the entire screen.

Look for ways to engage students. Effective techniques we've seen:

- Introduce a surprise. A surprise that reinforces what is being taught is even better.
- Include examples of related student interests.
- Start lessons in unexpected ways to grab the student's attention and interest. Consider a fun prop, short story, interesting question, or unexpected entrance.
- Speak in a conversational and personable manner. Avoid speaking slowly and formally: studies show this can decrease student engagement.
- Look at the camera. Without actual students in the room it can be tempting to teach to the floor or the wall. When you look at the cameras, students feel you're looking directly at them.
- Include students in the video if doing so will enhance the learning experience. Most Acellus videos are filmed without students in the studio.

Be mindful of the needs of diverse learners when preparing and filming course content. Acellus courses are offered at:

- Public schools
- Charter schools
- Private schools
- Faith-based private schools
- Distance learning schools
- Home schools
- Libraries
- Detention centers
- etc.

The Don'ts

Never date content. Be careful to not tie the course to a specific time period by discussing current news events or by using phrases such as yesterday, tomorrow, last year, and so on. When years are needed – for example, when teaching students how to write a letter – we suggest using dates at least five years in the future.

Never tie lesson to a location. The student should feel like the on-camera teacher is where the student is.

Never tie lesson to a particular time of day or season. Don't begin a lesson with "Good morning" or "Good afternoon" or mention the weather outside today unless it is relevant to the lesson.

Never tie lesson to a particular age group. Rather than saying, "This is Freshman Biology," say, "This is Biology." Older students may be taking the course.

Avoid offending any part of the target audience. Cover sensitive subjects with respect, taking care to not insult any viewers' moral beliefs. When discussing controversial topics, cover varying viewpoints in an unbiased manner.

Never ask students to do something they may not be able to do. Not every student can go to the library or browse the Internet, because they may not have access. Not every student can get permission from their parents, because they may not have parents or their parents might not be local. Better to say, "You will need adult supervision."

Never assume that materials and supplies are readily available to students. Bring your own supplies to the studio and model the activity for the students.

Don't refer to previous or future content. The order of lessons in a course may later be shuffled. Avoid statements like, "In the next lesson..." or "This is the last lesson in this Acellus course."

Don't refer to your lecture as a "video." Students should feel like they are being taught one-on-one and that the teacher is right there connecting with them. Phrases like "in this video" point out the fact that the lesson is pre-recorded.

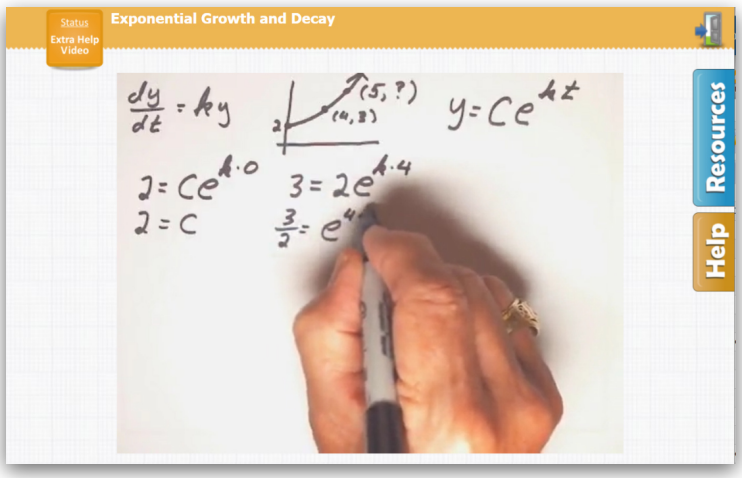

Figure 4.10: Help Videos provide students with an example of how to solve the kind of assessment item they are learning about.

Developing Acellus Help Videos

Everyone learns differently. Some students need more than one explanation to comprehend a given concept. When students struggle, Acellus analyses why. Sometimes the solution is to provide additional explanations in the form of Help Videos – short videos designed to ***help*** students learn how to solve a specific type of assessment item (Figure 4.10).

In a Help Video, the "instructor" answers a sample assessment item, ex-

plaining how it works as the video progresses. The assessment item is similar to those the student is working on, but not exactly the same.

Help Videos can be filmed by a member of the courseware team using a document camera, showing just the problem and the instructor's hand – and sometimes other graphics. Alternatively, Help Videos can be filmed by the on-camera teacher in an Acellus Studio, assisted by the full power of the Studio.

Help Videos are accessed by students via the Help Tab, which is available during lesson assignments and reviews. This means that help is available to students when they are the most open to receiving it – when they ask for it (by selecting a Help Video).

Help Videos are particularly useful to students who are stuck on the assessment items and need a quick, focused review on how to solve them. Often multiple Help Videos are created for one assessment step, giving students a better chance of understanding the concept – because everyone teaches differently, too.

Teaching On-Camera!

Lights...

Camera...

TEACHING?

Todd Edmond
On-Camera Teacher

There are some teachers who claim they are not entertainers. However, there is no doubt that a profession in education requires the ability to perform in front of others – in this case, students. The educator that is in front of the learner is responsible for the way the subject matter is presented and for holding the attention of the students themselves.

The Acellus filming system is very unique. It requires a teacher to step out of their comfort zone and away from a functioning classroom. The task can be overwhelming at first – often with the teacher having no idea how to instruct without actual students in front of them! However, with proper planning and preparation, teaching lessons to a camera can be both enjoyable and eye opening as an educator.

Once the outline is complete, an Acellus teacher can get to work on the “meat and potatoes” of the course – which also tends to be the greatest amount of work. The instructor needs to determine what needs to be taught, how best to teach it to a camera, and what visuals (if any) need to be presented. Research, time, and the preparation of materials is all a part of this phase. The teacher is the expert!

The goal is to have everything understood and ready to go by the time the teacher hits the studio for filming. The instructor should be a master of the material before the camera turns on.

This will allow for better flow to the lesson, and for the educator to *teach to the student*, instead of trying to remember what to say.

Filming in the Studio

When the time comes to film the course, an Acellus teacher should be completely ready to go. All presentation materials should be in the system. It is always a good idea to have either a hard copy or your laptop ready in the event you need to freshen up on each lesson before the camera turns on.

The key to reaching students is threefold:

First, you must be relaxed and not robotic in front of the camera. Students will become bored very quickly if you are simply stating facts or are going through the motions, trying not to mess up. Imagine you are in your classroom with students in front of you. Be lively! Smile! Act as though the kids are in the studio with you. The camera has become the face of your students! Enjoy the moment of teaching. Enjoy the subject you are presenting in the lesson. Show students your passion and love for teaching.

Second, it is okay if you make a mistake! This is the world of filming. If something goes wrong you simply need to start over and do it again. It will seem very weird at first to speak into a camera in order to teach. However, once you realize that you are still educating – that there are kids out there watching you – the flow of a lesson will come through. It may take a few lessons to get the feeling of talking into a camera down, but mistakes are part of the process. One take is not required! Relax and teach.

Finally, any good Acellus teacher must be personable in order to get through to the kids they are teaching. The material and curriculum are important. The students need to understand and grasp the concepts in each lesson. However, without a human being actually teaching it to them, it becomes lifeless. Add humor to your lessons. Make eye contact with the camera on a regular basis. Come up with a catch phrase to end each lesson such as, "see you next time!" The more personable you make your lessons, the more students you will reach.

Passion Makes Perfect

Every great educator loves to teach, and it shows. Students who walk into their classrooms (or their "studios") will automatically notice that they have a passion for their subject, for their teaching, for their students.

Think back to those teachers you yourself had growing up. Ask yourself why those teachers made learning so much fun. What did they do to make you want to come back again and again, day after day? Write those reasons down, and apply it to your teaching at Acellus.

The kids are still there with you. They are watching, listening, and learning everything you present. It may seem lonely and different in a studio, but the students are everywhere. Look into the lens, think of the kids, and do the job you have always done. In the end, great courses will be created for thousands of learners waiting for your instruction and passion!