HEADWATER
LEARNING SOLUTIONS

ALIGNED LEARNING

WHITE PAPER

JULY 2017

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01

Introduction

Given the task of designing a school experience aligned to the way people live, learn and work today—how many people would recreate the schools they went to? Education is an industry that's experienced pendulum swings based on trends. At the same time, it has managed to stay more-or-less static. Despite significant technological, social, and economic changes, many classrooms in schools today have a lot in common with classrooms in the 1950s. Education is misaligned.

The Traditional Model of Education

Having evolved from church controlled schools and single-room school houses, 20th century education in Canada reflected a factory or industrial mindset consistent with an industrialized economy. Students were batched in cohorts based on their birthdays, and they sat in rows to receive knowledge for set times. Classrooms were centered on the teacher who distributed facts, taught formulas, directed processes, and judged performance. Compliance was an expectation. Curriculum and testing became standardized with a focus on the acquisition of knowledge and procedures. The Carnegie Unit, a time-based measure of progress, was ubiquitous; advancement was based on meeting minimum requirements during time served rather than each student's knowledge and skill level ("The Carnegie Unit," 2015). Schools acted as a moratorium, keeping students out of the workforce, while also functioning as a sorting mechanism by placing students in streams ranging from vocational to university.

Where are We Now?

The broader conditions that support the traditional school model have changed. Economies have shifted. Advancements in technology, automation, and globalization mean that workers are more likely to work with knowledge and ideas.

They're more likely to work in fields requiring collaboration, innovation, and ingenuity. They're increasingly likely to be self-directed rather than micromanaged. As technological changes affect employment, there's increased incentive for entrepreneurship. Despite these changes, many elements of traditional schooling continue to be the norm rather than the exception. Students still tend to replicate what has already been done or work toward a single correct answer. They still generally focus on learning about a subject rather than taking action or thinking within the system of a subject. Classrooms are still teacher-centered and students are age-batched. Subjects are still typically siloed. Students still generally sit in rows and learn the same thing, at the same time, at the same rate and in the same place following bells and timetables.

> "Students are taught work habits and receive rewards for their performance. Students are issued workbooks, given work time or work periods, and are assigned seat work and homework
>
> **RITCHHART, 2015**
> P. 45

Work continues to be a dominant metaphor in traditional schools. Teachers are still classroom managers. "Students are taught work habits and receive rewards for their performance. Students are issued workbooks, given work time or work periods, and are assigned seat work and homework" (Ritchhart, 2015, p. 45). Clearly, learning to work is important. Adults work—but many workplace tasks and cultures have changed. Today's skilled workers are far more likely to deal with ambiguity, manage shifting information, generate ideas, construct prototypes, work in teams, and take initiative to solve ill-defined, nonstandard problems. Compliant workers who follow instructions and routines under the supervision of a manager no longer present the same value proposition they once did. Many of these roles are susceptible to being replaced by algorithms and robots. A new metaphor is needed.

Disruptive Technology

Whether they are getting out in front of it, going along with the flow, or being dragged from behind, schools are starting to experience disruption from advances in technology. A current way that technology is reshaping how we live, learn and work is accessibility. Knowledge is widely and immediately available online. Informal learning is expanding and knowledge is distributed among networks. Outside of school, students create, share, and curate content from multiple sources.

With mobile cloud computing, learning management systems, apps, social media, video conferencing, and productivity/connectivity platforms (e.g., G Suite, Office 365, and iWork), it's no longer necessary from an information and idea exchange perspective for students to be in the same room at the same time—or for them to learn the same thing at the same rate.

While students can now learn anywhere, anytime—the question is— to what degree should they? What is gained and what is lost? What's the balance? How can the benefits of cohorts and face-to-face collaboration be leveraged? Schools are deciding, intentionally or not—through action or inaction—how they will leverage technology. Most schools are maintaining traditional classrooms and schedules. Some use technology to digitize their current practice, but haven't significantly changed their approach. Others are intentionally integrating technology while redesigning learning spaces, the role of teachers, and students' learning experiences.

21st Century Learning

The 21st Century learning movement has become a significant driver of change away from the traditional school model. This approach focuses on skills believed to support student success in a rapidly shifting technological, social, and economic context. In addition to information/communication technologies and digital literacies, skills commonly advocated as 21st Century include creativity, collaboration, communication, critical thinking, innovation, problem solving, entrepreneurship, adaptability, local/global citizenship, information management, and economic literacies.

A challenge with 21st Century learning is that in many cases the term has come to mean everything and nothing. There are many cooks in the kitchen and fads for schools to follow. Depending on the flavor chosen, 21st Century schools can look very different from each other. The following ideas and approaches are current trends in education.

- ONLINE AND BLENDED LEARNING
- STUDENTS AS CREATORS, DESIGNERS, AND MAKERS
- DEEP LEARNING AND CONSTRUCTIVISM
- CONSTRUCTIONISM AND STEM
- COLLABORATIVE PROBLEM SOLVING
- CONNECTIVISM AND DISTRIBUTED KNOWLEDGE
- PERSONALIZED AND COMPETENCY BASED LEARNING
- VISUAL LITERACY
- REDESIGNED LEARNING SPACES AND TEACHER ROLES
- COMPUTATIONAL THINKING

02

Current Trends in Education

The traditional education model has demonstrated significant staying power, but the ground has started to shift under schools. While game changing disruptors like artificial intelligence and virtual reality are still a few years away from impacting mainstream classrooms, many changes are already taking hold or are poised to affect change in the next few years.

Online and Blended Learning

As opposed to homeschooling, where parents generally provide or supplement instruction, in online schools certified teachers provide instruction, support, assessment and reporting. Asynchronous learning is common through learning management systems where students can access media rich resources, screencasts, lessons, instruction, discussions, and shared collaboration spaces. Students can message teachers and submit work digitally, and they can often work together using connectivity and collaboration tools. Synchronous learning is also a feature of many online schools. This involves real-time classes using interactive web conferencing tools such as digital whiteboards and video/audio/chat tools.

Online learning is a growing area for many K-12 school jurisdictions in the U.S. and Canada. For example, in its 2015-16 annual report, Florida Virtual Schools—a K-12 online school program—had 207,400 students and saw a 25% increase in its year-over-year full time semester completions (Florida Virtual Schools, 2016). Locally, Calgary students can choose online options through CBe-learn, Alberta Distance Learning, and U-Learn. In its 2013-14 annual report, CBe-learn—the Calgary Board of Education's online junior and senior high school—included 4781 (7577 with e-learn) total course registrations (CBe learn, 2014). High school students learn asynchronously with certified teachers via a learning management system and can progress through content at their own rate. In the junior high, students learn asynchronously and also have weekly cohort-based synchronous classes were they learn in real time with teachers leading lessons using Blackboard Collaborate web conferencing software. The Alberta Distance Learning Center reported 57, 724 total enrollments in 2014/15, with a 79% completion rate ("Connected By the Numbers," 2015). Interestingly, 41% of enrollments are from urban and metro areas that are well served by other school programs. The Calgary Catholic School District offers online learning for high school students through their U-Learn program.

Why does online learning matter for students who are in traditional face-to-face programs? Online learning has become mainstream in post-secondary institutions. There's an increasing probability students will participate in online learning after they graduate from high school, and developing skills to self-manage and navigate those experiences presents an advantage. Students with the capacity for self-directed learning are much better positioned to succeed in post-secondary environments where support by teachers and parents necessarily fades.

The 2015 Survey of Online Learning (conducted by the Babson Survey Research Group in conjunction with Pearson, the Online Learning Consortium and other sponsors) identifies continued growth in

online learning. In the United States year-to-year increases in the number of students taking online courses is hovering at 4%, over a quarter of all post-secondary students now take at least one online course, and 71.4% of academic leaders rate online learning as either the same or better than face-to-face instruction ("Online Report Card," 2015). From a cost-effectiveness perspective, it's not unexpected that proportionally, at 72.7% of all distance learners, public institutions have the most undergraduate online students.

What's the picture in Canada? In 2016, a national survey of online learning in Canadian Universities was commissioned by Global Affairs Canada. The responses from 73 institutions across the country show online learning is now mainstream with 29% of students registered in at least one online course. Highlights include that 93% of Canadian universities offer online courses and 72% of the 809 online programs are at the undergraduate level ("A National Survey," 2016).

Since blended learning includes multiple variations where traditional and online schools intersect, numbers for blended learning enrollments are difficult to pin down. Blended learning is defined as a program in which a student learns "at least in part through online learning, with some element of student control over time, place, path, and/or pace; at least in part in a supervised brick-and-mortar location away from home; and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience" ("Blended Learning", n.d.). Blended learning programs encompass a large range of different designs and student experiences. On one end of the range, online learning is the center of instruction while students access some face-to-face support or experiences. On the other end, students learn primarily face-to-face with some online learning experiences. While blended learning approaches differ, in general they can provide increased program flexibility. Leveraging this model can facilitate the application of more personalized, standards based, and competency based teaching methodologies.

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>
> **"BLENDED LEARNING", N.D**

Deeper Learning Approaches and Constructivism

The concept of deep learning is gaining traction. The New Media Consortium (NMC) Horizon's report identifies deep learning as a mid-term trend that will drive educational technology adoption over the next three to five years (Adams Becker, S., Freeman, A., Giesinger Hall, C., Cummins, M., & Yuhnke, 2016). Deep learning is not a new idea or a single approach. Instead, it's a combination of approaches that shift students from a passive role where they receive pieces of knowledge into an active role where they engage with knowledge so that ideas become interconnected.

In some cases, the idea of thinking like those within a domain (e.g., think like a historian) is promoted. However, any interpretation that students can think like experts should be treated with caution. As Willingham (2009) points out, "Experts don't think in terms of surface features, as novices do; they think in terms of functions, or deep structures" (p. 133). Organizing information in long-term memory to facilitate transfer, manage abstractions, and think functionally involves significant background knowledge, sustained practice, and experience (Willingham, 2009). Research in cognitive science identifies that expertise encompasses "a large and complex set of representational structures, a large set of procedures and plans, the ability to improvisationally apply and adapt those plans to each situation's unique demands, [and] the ability to reflect on one's own cognitive processes while they are occurring" (Sawyer, 2008, p.4).

While students, as novices, may not have the capacity to think like an expert in a domain, they can apply critical thinking skills to think within the system of a domain and attempt to do the types of tasks those within a field actually do. This process involves asking strategic questions to uncover the underlying concepts, ways of thinking and the logic of a subject. Paul and Elder (2012) identify questions that students can ask and then explore to connect ideas. These include, but are not limited to:

What are people in this field trying to accomplish? What kind of questions do they ask? What kind of problems do they try to solve? How do they go about gathering information in ways that are distinctive to this field? What is the most basic idea, concept or theory in this field? (p. 164)

By identifying the goals, central problems, kinds of data used, underlying assumptions, perspectives, dispositions, and frames of reference people within a domain or field engage in, students can become more skilled thinkers leading to deeper learning (Paul & Elder, 2012).

Instructional design for deep learning is consistent with the Understanding by Design principle of uncoverage. Rather than covering a broad range of disconnected curriculum topics at a surface level (which is often the reality when teachers need to prepare students for tests) the goal is to

uncover meaning. By guiding instruction with overarching essential questions, enduring understandings and focusing on depth, students can construct meaning by acting like investigators to reveal or uncover knowledge, ideas, and connections that might have otherwise been missed (Wiggins & McTigh, 2005). Shifting curriculums from models centered on breadth to models focused on depth is a policy decision that supports deep learning.

An intended outcome of traditional, didactic approaches is for students to acquire meaning as it's delivered by a teacher—often in combination with rote learning methods. They learn about things. However, strategies for deeper learning generally focus on constructivist approaches which center on students creating meaning though experiences. Zualkernan (2006) connects constructivism with authenticity in social contexts that involve "access to expert performances," support "multiple roles and perspectives," and involve "collaborative construction of knowledge" (p.198).
Deep learning involves students taking action with knowledge and is frequently associated with inquiry methodologies. Rather than working toward a single, correct answer, these tasks are often heuristic. Daniel H. Pink (2009) defines heuristic tasks as those that involve experimenting with possibilities to "devise a novel solution" (p. 27).

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Constructivist approaches consistent with deeper learning are not without critics. Hattie (2012) identifies that methodologies such as inquiry based learning often don't have a high influence on improving student performance on standardized assessments. Approaches that focus on discovery learning can also sometimes result in what Willingham (2009) describes as "mental paths that are not profitable" (p. 82). Such concerns may be linked to an educational trend where inquiry projects focused on engagement rather than understanding as an end goal and where students freely pursued their own purposes. The idea that it doesn't matter what you learn—only how you learn—is not consistent with deep learning.

Done well, constructivist instruction is an approach that can lead to both deeper student understanding of knowledge as well as increased engagement. Gold Standard Project Based Learning is a methodology that supports deep learning through a disciplined, scaffolded process that focuses on a challenging problem or question and sustained inquiry as an organizing structure for "mastering knowledge and concepts" and the "ability use and apply that understanding in the future" (Larmer, Mergendoller, & Boss, 2015, p. 35). If students are unable to transfer their learning to new contexts, it's unlikely that deep learning has occurred. Deep knowledge is "hard-won" and is the result of sustained practice through which learners, over time, develop deeper structures (Willingham, 2009, p. 104).

Collaboration and Collaborative Problem Solving

Deeper learning is enriched with collaboration. Felix (2005) suggests applying a synthesis of cognitive and social constructivist approaches where "knowledge is constructed individually, but mediated socially" (p. 86). Collaborative problem solving, as defined in the PISA 2015 Draft Collaborative Problem Solving Framework, is "the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come up with a solution and pooling their knowledge, skills and efforts to reach that solution" (2013, p. 6).

While cooperation and collaboration are sometimes used interchangeably, there are distinct differences. Cooperation involves a "division of labour among participants, as an activity where each person is responsible for a portion of the problem solving" while collaboration is "the mutual engagement of participants in a coordinated effort to solve the problem together" (Roschelle & Teasley, 1995, p. 70). Randy Nelson, the former Dean of Pixar University, Head of Artistic Development and Training for DreamWorks animation, and Director of Apple University, describes collaboration as a process involving co-creation or co-production. He considers it to be a "higher order skill demanding more than cooperation" where each person brings "separate depth to the problem [and] separate breadth that gives them an interest in the entire solution" (Nelson, 2008). Felix (2005) discusses the need to "invest serious time" to issues such as group dynamics, assessment and student engagement in a learning setting that "emphasizes risk-taking while allowing students to make errors in a safe environment" (p. 92).

Personalized and Competency Based Approaches

Personalized learning is a current buzzword in many educational circles. While there are multiple, sometimes inconsistent definitions (often confused with individualized or differentiated learning), in general personalized learning refers to students following personalized or customized learning paths where they have a degree of choice in what, how, where, and when they learn (Patrick, Kennedy, & Powell (2013). Achieving personalized learning is difficult in traditional classrooms that follow the one size-fits-all, Carnegie/seat-time model of learning progression.

Competency based approaches focus on a different progression model. Student move from one competency or level to the next by demonstrating proficiency with curriculum standards. Sometimes called mastery based learning, competency learning supports personalization as students progress as fast as they can, but as slow as they must. They are not tied to the achievement level of their age-based peers. The continuous progress nature of this approach is consistent with a growth mindset.

There are multiple ways to operationalize competency based approaches from online learning and adaptive learning systems, to low tech binder and paper environments, to projects. Competency learning can involve adaptable face-to-face cohorts, models where students rotate between stations, and flex models where students learn through variations of blended learning. Gamification, where students level-up and game elements are integrated, is another approach. These methodologies are competency based so long as progression is tied to proficiency/ mastery over clearly articulated standards.

Redesigned Learner Spaces and Teacher Roles

Schools provide a supervised, predicable environment for students to interact and learn while parents are at work. However, should schools today look like schools in the 1950s?

The traditional teacher-centered model is predicated on standardization, hierarchy, respect for authority, and compliance—as would be expected in a factory system. Social norms and expectations have changed. Students today are less inclined to adhere to rigid structures and acquiesce to authority figures while parents are less inclined to support teachers on discipline issues. Traditional classrooms disconnect subjects from each other, age batch students, require a lot of sitting, and are time based. It can be difficult to create flow with timetabled subjects. Students are required to sit in class even if they know the material while those who need extra help might be left behind as lessons proceed. Hallways are typically empty except when the bell goes. Then there's high traffic transitions. Maintaining traditional, siloed, scheduled, time-based classrooms where students have little agency may increase dysfunction and disengagement.

Frederik Pferdt, Head of Innovation and Creativity at Google, describes physical space as "the body language of an organization" ("Creating an Innovative Workplace," n.d.). Redesigned learner spaces generally aim to increase flexibility and flow with modernized aesthetics. A learning commons is a prevalent feature. These are flexible open spaces with multiple seating configurations, often derived from existing libraries, where students can work independently or collaboratively. As a school hub with connectivity and community in mind, they are designed to be multi-disciplinary, learner centered spaces without a central focal point for teacher instruction. A learning commons is only one part of a well-designed physical space, and many students may find an open, often noisy location a distracting place to learn. Other learning space redesigns include quiet, teacher supported subject area hubs, seminar rooms, studio spaces and maker spaces. Subject area hubs are often much larger than a typical classroom and support multiple grades or levels. The architectural design of changing learning spaces is less institutional, reflecting a move away from isolated classrooms. These spaces may not have a front-of-the-room where a teacher resides. Instead, they are suited for inquiry projects as well as flex learning where students have more agency over where, with whom, and when they learn.

Teachers' roles are also changing. Popularized by Clayton Christensen in 2008, the idea of teachers moving from the sage on the stage to the guide on the side is now a cliché. While teaching by PowerPoint lecture and other didactic approaches remain common in many secondary classrooms, the traditional role of teachers as the keepers and distributors of knowledge no longer makes sense. Instead, as learning becomes more student centered, the role of teachers has shifted to facilitators, advisors, and learning coaches. Formative assessment is gaining importance as a skill set for teachers to help students achieve a standard or competency.

Students as Creators, Designers, and Makers

Creativity is one of the four Cs associated with 21st Century learning.

The NMC reports that "a shift is taking place in schools all over the world as learners are exploring subject matter though the act of creation rather than the consumption of content" (Adams et. al., 2016, p. 18). A multitude of digital design apps/programs, social media, and other sharing platforms make it relatively simple for students to produce and publish for an audience beyond their teacher. Implications for this trend include privacy and digital citizenship issues. Schools are now in a position where overtly addressing ways to navigate this area, such as adhering to and applying Creative Commons licenses, are necessary parts of instruction. Maker spaces and design thinking models like spiral design and rapid prototyping are facilitating the development of skills/dispositions consistent with innovation. These include thinking of something novel that has value, and then engaging in a process to prototype, iterate, and improve on the product.

Constructionism and STEM

Constructionism is a theoretical approach to learning that applies many principles of constructivism.

Borrowing from the ideas of Dewey and Piaget, Seymour Papert developed his theory of constructionism based on a belief that "children learn by doing and by thinking about what they do" (Papert, 1972a, p. 253). Constructionism shares the constructivist idea that learners build or construct knowledge through their experiences, and it extends this idea to emphasize the concept of learning where students are intentionally engaged in making a physical or sharable product (Papert & Harel, 1991). Learning is approached through projects that allow students to try different ideas in multiple iterations so that they can become personally involved in the process, learn from mistakes, keep what works, and improve upon what doesn't (Martinez & Stager, 2013). Constructionist learning is consistent with hands-on Science, Technology, Engineering, and Math (STEM) initiatives. STEM is morphing into STEAM in some schools as the arts are intentionally integrated. Examples include 3-D design/printing, wearable technology, robotics, and physical computing as well as low tech projects that apply building materials and craft supplies. Often, high and low-tech approaches intersect.

Connectivism and Distributed Knowledge

The Internet, cloud computing, and inexpensive data storage has led to exponential growth in knowledge as well as a rise in informal learning. In the connected era of big data and algorithms, our daily habits, taps, clicks, and activities are mined for information that can be used to sell us things, customize our experiences, and track our behaviors. Enormous amounts of data are available to anyone with an Internet connection. Knowing how to find, curate, critique, and leverage distributed knowledge is an emerging skill set.

In the 20th century model of secondary education, knowledge was distributed by a teacher and—to a lesser degree, textbooks, encyclopedias, magazines, newspapers, library books, and journals. While trends are emerging to leverage networks and distributed knowledge in schools, teacher-centered, PowerPoint heavy classrooms are still common, and teachers continue to prepare students for high stakes exams based on memorization. Few teachers would disagree that memorization and the automaticity it brings have value, but other representations of what students know and can do are also valid. Sawyer (2008) argues that "in today's schools, there's a belief that a student only knows something when that student can do it on his or her own, without any use of outside resources" resulting in a "mismatch between today's school culture and the situated knowledge required in the knowledge society" (p.7).

Outside of their classes, students use personal networks, apps, social media, and online resources like YouTube to learn what they haven't been (formally) taught. George Siemens addresses non-linear knowledge acquisition and the way technology is reshaping how we think and interact in his connectivism learning theory. Connectivism involves the idea of connecting "specialized nodes or information sources" into networks, and it identifies that the "capacity to know is more critical than what is currently known" since "new information is continually being acquired" often shifting the foundations on which previous decisions were made (Siemens, 2005, p.5). Learning, or actionable knowledge, is continual and involves "nurturing and maintaining connections" (Siemens, 2005, p.5). A current challenge for schools is determining how to incorporate distributed knowledge into students' formal learning experiences.

Visual Literacy

The common expression, a picture is worth a thousand words, has given way to a new and distinct reality for a new generation. Today, a single image or video can be shared thousands of times in an instant—and millions of times if it goes viral.

The origins of images have been democratized. They're no longer only from mainstream media, publishing, and marketing sources. We're now all content creators and publishers with a potential global audience. Many students today live in a Snapchat, Instagram and YouTube world. The apps may change, but a new constant is that students are continuously bombarded by images that influence and form their perceptions. These images can represent or misrepresent. Students regularly create, share and receive images/videos within a broad network of people via social media, many of whom they've never met.

As a result of this shift, visual literacy is one of the new core emerging literacies to be taught with the same intention as reading, writing, and mathematics—focusing first on the fundamentals, so that students are better able to understand, interpret, and create in the visual world that is their reality. The Association of College and Research Libraries defines visual literacy as "the ability to recognize and critically appreciate meaning in visual content and to use visual elements to create effective communication" ("ACRL Visual Literacy Competency Standards," October, 2011).

In traditional education, instruction of visual literacy skills was confined for the most part to the fine arts classroom. As we reach the tipping point where something unique has now become common (Gladwell, 2002), we must expand our views of the concept of visual literacy to match the reality of today. A goal of education in this new normal is for students to become critically autonomous, learn to ask the right questions, and to become discerning consumers/creators of visual media.

The Jacob Burns Film Center identifies two essential understandings for developing a foundation for literacy in a visual culture: viewing and creating. A visually literate student "applies close observation, meaning making, and interpretation. They develop an aptitude for connecting form and content, understanding that texts are a collection of choices which impact meaning and emotion" ("We're teaching literacy," n.d.). As students become proficient with breaking down the components of critical viewing, their next challenge is to tackle the understanding and processes required for effective and impactful expression ("We're teaching literacy," n.d.). The ubiquitous presence of visual media in our daily lives, combined with the participatory culture in which our students live, necessitates that students are capable and critical viewers and creators within the realm of this emerging literacy.

Computational Thinking, Coding, Robotics, and Programmable Electronics as Literacies

While automation and off-shoring have deeply impacted blue collar factory jobs in North America over decades, students now have to consider which white collar jobs and careers are likely to be replaced or impacted by algorithms and robotics.

Emerging literacies, like computational thinking, are relevant for students to be able to participate effectively in an environment where technology is dramatically changing the dynamics of employment and entrepreneurship in a way not seen since the Industrial Revolution.

Technology use in mainstream education has essentially been about teaching students to be effective consumers or users of technology. This trend is continuing with emerging technologies such as augmented reality. While students have grown up with technology and many are tied to their devices, they are still acting as consumers. Martinez and Stager (2013) raise concerns about "a generation of young people becoming passive users of technology they neither understand nor control" (p. 110). There's currently growth in educational approaches that delve into how the devices we use every day actually work. For students, learning to code is about having agency

over how technology interacts with people while also developing in-demand STEM skills (Adams et. al, 2016).

Coding is much more than learning technical programming skills. It involves ways of thinking and problem solving. The RoboMatter curriculum connected with Carnegie Mellon University describes computational thinking as a transferable problem solving process through which students learn to be "precise with their language, base their decisions on data, use a systematic way of thinking to recognize patterns, and break down larger problems into smaller chunks that can be more easily solved" ("Computational Thinking," n.d). The International Society for Technology in Education (ISTE) includes computational thinking as one of its seven categories of standards for students. Computational thinking standards focus on "understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions" (ISTE, 2016).

Robotics in education apply coding and computational thinking within a physical, object oriented environment. Rather than watch their code in-action on a screen, students see how their code works in the real world.

Robotics in education apply coding and computational thinking within a physical, object oriented environment. Rather than watch their code in-action on a screen, students see how their code works in the real world. By learning how to code and apply computational thinking in an environment like RobotC, students develop skills that can transfer to industry standard programming environments. The 2016 NMC Horizon Report for K-12 identifies the time to adoption for robotics in mainstream education at two to three years (Adams et. al, 2016).

Many of the electronics we use today are programmable. The Internet of Things refers to the integration of connected devices. Small microcontrollers, sensors, and actuators are commonly applied to turn electronic components into connected or smart devices. For students, there are multiple physical computing platforms, like Arduino, to develop literacies so they can understand and participate, rather than just consume in this area. Applications include maker projects, wearable technology, and authentic, hands-on science.

03

Aligned Learning

Aligned Learning Overview

Aligned Learning is an approach that focuses on aligning learning with students' lives outside of school, how technology is reshaping the human experience, social-emotional wellness, jobs/entrepreneurship, and globalization. At its core, Aligned Learning involves advancing traditional and emerging literacies while integrating opposing elements. On the one hand, it creates experiences designed to increase student agency and guide students to become self-directed leaders of their own learning. On the other hand, it creates experiences for face-to-face collaboration where students engage in interdisciplinary problem solving—often managing ambiguity and applying project management criteria. Aligned Learning is balanced, recognizing there is a place for direct instruction, seminars, and labs.

Realigning education starts with an understanding of learning. What does it mean to be a learner or student? Learning includes acquiring, remembering, and taking action with knowledge. Since memory is interconnected with thinking, enduring change comes from experiences and sustained practice where students think about meaning (Willingham, 2009). In Aligned Learning, knowledge and content clearly matter—but acquiring knowledge is only one step. Developing self-management skills and dispositions to do something with that knowledge is vital, as is collaborating with cohorts and networks to ask questions, think critically, problem solve, prototype, create, and iterate.

Aligned with Students' Lives Outside of School

Learning reflects the digitally connected, constantly changing world in which students live. With Aligned Learning, students think critically, create, collaborate, and share while developing visual literacy and digital citizenship skills. Students engage in meaningful tasks where they apply processes and tools that are reflective of real-life contexts.

Aligned with How Technology is Reshaping the Human Experience

Learning develops literacy with computational thinking as well as technologies to fully participate, adapt, and flourish in a rapidly changing world. Rather than simply being consumers of technology, students will explore beneath the surface to learn coding, robotics, digital/3D design, and physical computing/programmable electronics. Learning experiences are structured to develop dispositions of adaptability, flexibility, inquisitiveness and persistence.

Aligned with Agency and Social-emotional Wellness

Learning focuses on student agency and sense of self. Agency is defined as "the capacity and propensity to take purposeful initiative—the opposite of helplessness. Young people with high levels of agency do not respond passively to their circumstances; they tend to seek meaning and act with purpose to achieve the conditions they desire in their own and others' lives" (Ark, T. V., (2015).

In Aligned Learning, shifting educator roles and instructional design increases student choice, voice, and responsibility while also providing just-in-time supports. Daniel Pink (2009) argues that a sense of autonomy over time, task, technique and team is empowering and increases both motivation and satisfaction. An intentional focus on developing self-management and collaboration skills advances capacities for students to become co-leaders of their learning. Each student's advisor becomes a regular support and contact person over several years. As mind and body are connected, physical health and active living is integrated into the school experience.

Aligned with Jobs and Entrepreneurship

Learning responds to economic change by aligning instruction with relevant capacities for success in the real world. In addition to learning core skills and emerging literacies, students receive guided practice with project management, self-management, and digital literacy. Self-directed learning is integrated with interdisciplinary, cohort based projects. Immersive experiences develop team work and task-work skills essential for collaboration while approaching rigorous curriculum standards centered on themes, problems, enduring understandings, and essential questions.

Aligned with Globalization

Learning challenges students to be productive, culturally aware global citizens. Intentionally designed experiences engage students in global issues, questions and opportunities with a focus on competencies and dispositions to thrive in an interconnected world. Outside experts and groups work with students both face-to-face and digitally.

Aligned Learning and Educational Theories

Aligned Learning involves integrating elements that appear to be in opposition. Rather than focusing on one learning theory—like constructivism—and disregarding others, this approach looks at crossovers and areas of intersection. Is there value in reframing and modernizing the best parts of what preceded current trends?

Behaviorism—with a focus on observing stimuli, responses, and reinforcement, was dominant in shaping the traditional model of education. Today, many reject the "behaviorist assumption that children enter school with empty minds, and the role of school is to fill up those minds with knowledge" (Sawyer, 2008, p. 6). Behaviorism is often seen to be in opposition to 21st Century learning. However, behaviorist applications like programmed instruction and "nonhuman mediated instruction" continue to have influence (Smith & Ragan, 2005, p. 26). Adaptive learning systems are a future trend in education and have links to behaviorism. Other influences include practices that emphasize mastering a prerequisite level supported with informative feedback and tangible rewards before moving to the next, more complex step (Ertmer & Newby, 2013), p. 49). Seen from this lens, elements of behaviorism may be aligned with parts of current instructional design from gamification to competency based approaches.

Behaviorism focuses on environmental factors. Cognitivism takes a different approach. Cognitivist theory, which became dominant in education, centers on "cognitive structures, processes, and representations that mediate between instruction and learning" and "the role of the learner as an active participant in the learning process" (Smith & Ragan, 2005. p. 26). Areas of focus in cognitivism include determining how prior knowledge is connected to new knowledge; the role of short-term, working, and long-term memory; inputs/outputs; schemata; and mental models.

Cognitivist theory is consistent with approaches that advance skills and dispositions for self-directed learning. Its focus on input, storage, retrieval, and organization of information in memory can be applied to help students "develop skills that involve improving their own thinking processes, such as setting their own learning goals and monitoring progress in reaching these" (Dede, 2008, p. 49). Cognitivism is relevant to the Aligned Learning objective of thinking within a system which involves developing conceptual frameworks. Advancing metacognition and reflection are cognitivist principles that continue to be highly relevant.

Social constructivism, a learning theory developed by Lev Vygotsky decades ago, has become popular within 21st Century learning circles. It focuses on social learning experiences where students construct understandings through experience, collaboration, and negotiation. The theory draws on Piaget's constructivist principles that the learning process is active; meaning is constructed from personal interpretations and experiences (Smith & Ragan, 2005). Constructivist approaches value inquiry-based learning and facilitated rather than didactic forms of teaching (Powell & Kalina, 2009). Examples of social constructivist learning include

students solving ill-defined problems in a project or challenge based context where they have increased agency to shape their learning through extended inquiry.

Which learning theory is best? It depends. Just as one-size-fits-all learning environments no longer make sense, it also doesn't make sense to force learning into the box of a particular theory. A goal of Aligned Learning is for students to engage in extended collaborative inquiry projects to solve interdisciplinary, ill-defined problems that don't have a single right answer. However, does it make sense to always start the learning process there? Can inquiry fatigue result from full time constructivist approaches? Applying social constructivist principles is an effective way to take action with knowledge, but not necessarily the best place to start. A foundation of background and domain specific knowledge provides something of value for students to think about in order to construct meaning or problem solve. This learning can be just-in-time, or it can take the form of prerequisite learning. Automaticity reduces cognitive load so that working memory can be utilized to make connections and form deeper structures. There's a role for memorization and strategies like mnemonics. And, while capacities for heuristic problem solving are important, so are capacities for algorithmic problem solving. There's a place for following ordered, step-by-step processes to determine a single correct solution.

Ertmer and Newby (2013) suggest that behaviorist approaches might facilitate knowing the what—such as mastering content; cognitive strategies facilitate knowing the how—such as tactics for problem solving, concept formation, mental planning, and organizational strategies; and constructivism is suited to "dealing with ill-defined problems through reflection-in-action" (p. 60). Willingham (2009) writes that developing an understanding within a discipline involves memory and extended practice in order to gain a basic competence that can then help learners arrive at deeper structures (p. 125). These basic competencies may then enable more effective learning within a collaborative, co-construction context. "As one moves along the behaviorism—cognitivist—constructivist continuum, the focus of instruction shifts from teaching to learning, from the passive transfer of facts and routines, to the active application of ideas to problems" (Etmer & Newby, 2013, p. 59).

Implications

Technology, automation, and globalization have transformed how we live, learn, work, and interact. It's unreasonable to teach students using strategies and tactics more aligned with the past than the present. Schools that do so are increasingly irrelevant. It's also unreasonable to think that our approaches to teaching and learning today are future proof. Planning for and adapting to accelerating change is now part of the teaching profession—which itself is likely to undergo significant change as new disruptors like artificial intelligence and virtual reality are poised to change existing paradigms. Aligned Learning is an approach for embracing emerging literacies, developing student agency/self-directed learning skills, and enhancing capacities for collaborative problem solving. It's time to realign learning by integrating seemingly opposing elements—like self-directed learning and collaboration— to advance students' capacities and dispositions to thrive in the global knowledge and innovation economy.

04

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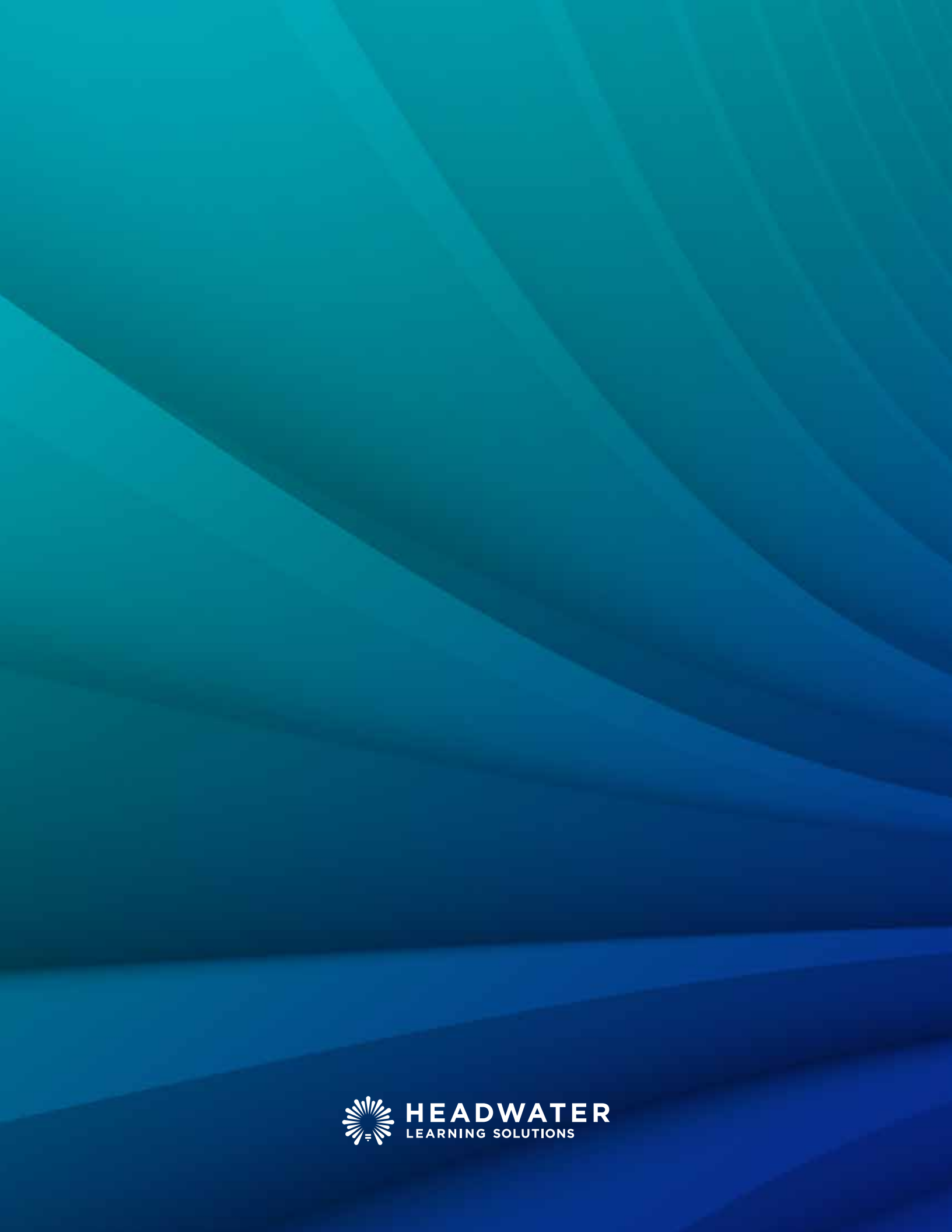
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