Toward a Unified Computer Learning Theory: Critical Techno Constructivism

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Schools are not known as places that move quickly in response to changing philosophies, burgeoning innovations, or marketplace attitudes outside of themselves (Educational Technology in the 21st Century, 1995; Micheuz, 2009). While innovations in the fields of art, medicine, and science evolve, the re-imagined classroom of the future that many have dreamt of and written about for nearly forty years has yet to take hold (Harel & Papert, 1990). Most people would leave a doctor’s office upon seeing that the most current and available tools were from fifty years ago. Most people would have their doubts about the effectiveness of the doctor’s approach if the office visit talk consisted of old strategies about which you had read many criticisms. In schools, however, students, teachers and families alike have grown to tolerate the anachronism (Feenberg, 2002).

Technology use in education can certainly speed up our use of paper and how we process and access information. In fact, that is the most understandable and basic goal of using a computer and the one that brings most novice users to convert their workflow to digital. However, replacing paper simply maintains things as they are. For decades, the machine has had the potential for more uses than yet discovered. Why invent a new gadget to teach the same material in the same way (Papert, 1972)? To disrupt the norm, the thoughts within this paper aim to urge the conversation about how to get students to learn together with computers and technology, not isolated individually in a corner at a computer terminal. Shifting the emphasis of computers in the classroom to a blended or mixed reality will empower the students and undermine the critics (Educational Technology in the 21st Century, 1995). Noting that the preposition change from “at” to “with” is more than a decorative device of language, the entirety of the approach with children and computers needs remodeling.

Again, and even at a glance, one can readily accept as true that the institution of school is known to move slowly in response to changes in society at large, but this pace does not match the students themselves who change rapidly and frequently in response to those same changes. Students daily bring to campus an abundance of microprocessors and have grown reliant on the widespread availability of high fidelity wireless Internet connectivity (Yoo, 2015)—school communities have witnessed a “new normal” with student familiarity of computing devices, computing literacy, and multi-user engagement in online virtual environments. This near-silent shift has occurred over the last ten years, during which time, some observed a widening gap between the kinds of jobs available and the relevance of subject matters studied in schools (Kellner & Kim, 2010). Additionally, schools and classrooms faced a greater number of restraints placed on curricula and student outcomes due to accountability and funding policies that largely dictate how administrators allow their teachers to use class time for what is sold as “in the interest of students.” Students at earlier and earlier ages were far more flexible with more complicated tools than what their schools provide (Kafai & Burke, 2015). This indicates a gap
between student readiness and school preparedness that often went unrecognized and undisussed. As schools set their “June outcomes” during the previous June, educators and administrators may then end up with predetermined outcomes that limit student growth and creativity, as well as their critical thinking and problem-solving skills. The growing mismatch and divide happens as a direct result of decision-making that disregards available data.

Global interconnectedness via Internet and pocket-sized devices to create, distribute, and access information has grown exponentially. The explosion of available information as well as an ongoing reliance on computing to access, collect, and share information, has resulted in an amplification of the already well-documented “digital divide” (Attewell, 2001) that politicians, philosophers, and philanthropists have worked on for at least two decades. A recent study (Araque et al, 2013) indicated an important reminder: increased availability of Internet access and computer hardware alone still did not improve the chances for low-income families to emerge from poverty. Training and support along with leveling the playing field had a greater chance for helping families to improve their station. This same equation for helping people to help themselves applied not only to families in their homes, and communities at large, but also students in a classroom. Teachers were often given a single computer for their classroom, or perhaps a school had a single computer lab for many classrooms, but even when a 1:1 computer program was implemented, training and support were still often lacking. As a result, the computer hardware and software were not utilized to transcend or transform lives, minds, curricula, or schooling. In other words, the yet unrealized vision of computers in schools as a radical liberation tool still awaits us: “High quality hardware and educational software alone cannot make this change and will not result in better educated students: educators need to change for this transformation to begin” (Troutner, 1991, p. 14). Fundamental shifts in daily classroom life for students can happen with guidance from research and theory, which has had great potential for decades to influence school leadership at the highest levels.

In a 1995 Congressional hearing on Education and Technology, Dr. Seymour Papert said, “I think there’s an education establishment that has its head wedged in a culture that grew up over a century during which there was the most lethargic progress in education of all fields of human activity and they continue to suffer from being part of that culture” (Educational Technology in the 21st Century, 1995). This paper is founded on established writings that encompass the field, even reaching into some texts that were written before the advent of the computer; those authors discuss relevant fundamental principles and attitudes that directly relate to a reimagining of classroom computer use. Further, many articles have been written by educators, social critics, pundits, philosophers, parents, and industry moguls. New ideas are prevalent, perhaps in an overwhelming abundance, but how many of these ideas make their way to teacher and administrator credential programs? How many of them assist in guiding the work of training the very people charged with creating experiences for student growth and learning? And how many ideas penetrate the very heart of the system itself and position themselves in opposition to the status quo?

Computers today have incredible processing power far beyond most of the utilitarian purposes they serve in schools today. This is not entirely surprising given the history of teaching machines and learning machines, which were created as rote learning devices reliant on behaviorism as the main teaching strategy. Presenting students with stimuli to which they must respond represents the majority of both the historical and the current usage of computers in classrooms. Missing are the expectations that when students work with computers that they can
create original content and explore problems or develop critical thinking skills through the process of following their own inquiries.

In this age of test scores tied to budgets, typically only that which would increase test scores would survive a budget cut—dreaming up a new curriculum or pedagogy with computers does not have guaranteed funding nor very many promises of funding. An experimental program where students “learn by doing” in a shared experience with a three-dimensional creative space sounds intriguing, but it will typically lose the funding face-off with a program trusted to keep the core subject standardized test scores reliably strong and growing. Furthermore, many people might expect students to figure out how to use computers on their own outside of school, given the preponderance of devices and websites and apps readily available.

And while some schools and educators work with the guidance of International Society for Technology in Education (ISTE) and Partnership for 21st Century Learning (P21) in their lessons and outcomes, it is certainly not the order of the day nor the requirement at most school sites. To push at this some more, all of this occurs in a simultaneous space where educators, scientists, and parents often acknowledge the unmet needs of students to find their voice and style, and to find individualized pathways of learning. In other words, we have more tools and venues available than ever before for students to discover an individualized interest and focus, but are slow to let them have greater value, weight, time, and space in our classrooms. The rhetoric of meeting students where they are is at odds with the diagnostic tools used to determine that location.

Digital Learning Environments (DLEs) that are safe and sanctioned by schools can offer opportunities for students to develop essential 21st Century skills, such as cognitive flexibility, electronic civic engagement, computer science literacy, judgment of source material, collaboration, and complex problem solving. Further, DLEs can help provide spaces for students to remix concepts and objects in search of new innovations to help better serve humanity. As cultures and societies change, new needs for systems emerge, towards which students could be working with real data to produce ideas and prototypes. Too often the benefits of creative collaboration receive short shrift when pitted against one’s individual academic progress.

Digital learning environments (DLEs) can also be powerful creative places for students to create, share, and explore a variety of cultural expressions in a diversified and meaningful manner. Underrepresented students are most often the marginalized voices in our classrooms. Educators seek pedagogies that emphasize inclusivity of all student ideas and experiences into the central narrative of the classroom. Using DLEs with a methodology steeped in critical theory and techno constructivism allows schools to create more places and pathways for students to express themselves, develop critical inquiries into their own assumptions and interests, challenge the assumptions of others, and deepen their connection to a lifetime of learning. It is incumbent upon schools to not only create and nurture these spaces for students, but to also train their faculty on how to use them and rethink their methods from previous years. The culture shift has already rapidly occurred outside of schools; now we must find a way to follow suit inside of schools.

This paper exists to lend its voice toward a unified learning theory for computers, computing, and digital learning environments for others to implement in their own practices and studies. There exists a two-headedness of behaviorism and constructivism in education, with particular focus on classroom computer usage and classroom computing. There is a high incidence rate of behaviorism alongside a high interest rate in constructivism. The relative absence of critical theory in techno constructivist thinking is a dilemma to explore and directly
address for the purpose of finding unification of these ideas, hence the title of this piece and the ideas herein—Toward a Unified Computer Learning Theory: Critical Techno Constructivism.

The larger significance and purpose here is also practical in looking for and asking for new approaches to school and the perpetually changing needs of students. In a digital learning environment, teachers and students have enormous potential for multimodal and multivalent approaches, as well as multiple entry points. Many classrooms today have access to incredibly powerful machines that can create an immersive and effective John Dewey-inspired learning environment that honors the students and the teachers, and even more, honors the process of creativity in pursuit of knowledge and production.

It is impressive to find that so many elements of the great constructivist thinkers instead of conflicting with one another can commingle and co-exist in our modern computing era. Once superimposed on each other, these elements begin to point toward a new approach, a new theory, a new classroom experience, and even a new graduation standard.

Looking back at the roots of computers in education, the main use and pedagogical design of the Pressey “teaching machines” was to encourage automaticity of skill and content in narrowly defined sets of data (Pressey, 1926). As the processing power of computers became powerful enough to allow for new designs in software and approaches with pedagogy, constructivism and constructionism were looked to for new possibilities and potential for how to use computers in schools. With all these changes in the potential and power of the “teaching machines,” however, the approach many schools take has remained more closely aligned with behaviorism and cognitivism. The ideas derived for this piece were created from a document analysis (Bowen, 2009) of seminal works from John Dewey (1916), Paulo Freire (1970), and Seymour Papert (1980) for the purpose of adding to the existing theories of computer use in classrooms and further developing a unified learning theory for computers, computing, and digital learning environments.

In sum, the words “technology and education” all too often means “inventing new gadgets to teach the same old stuff in a thinly disguised version of the same old way” (Papert, 1980, p. 353). Most software used in classrooms for the past four decades has relied on closed loop situational data simulations and narrowly focuses students on predetermined sets of information—this is “edu-tainment”, not education. Put another way, this is a transactional approach and not a transformational approach. Today’s modern learners are ready for educators and leaders to figure out a new and comprehensive approach to effectively teach with the Internet in digital learning environments (DLEs)—and keep in mind that the power, the reach, the accessibility, and the information contained there within expands each month with no foreseeable limit. That students should be subjected to a model of education that strips them of their natural intellectual and creative value is itself a crisis. In its place, Critical Techno Constructivism can help create nurturing and meaningful learning environments for all students.

Critical Techno Constructivism abides by the following principles:

• Social justice is a goal, not a topic.
• Predetermined outcomes limit creativity, intellectual growth, critical thinking, and problem-solving skills.
• Student inquiry must drive curricular choices and learning outcomes.
• Downloaded, purchased, or otherwise imported curricular materials and solutions are inadequate substitutes for developing original and relevant course materials.
• Computer programming is a mediating language between ideas and people.
• Guidance, coaching, and formative assessment replaces testing.
• Computers and electronics are objects-to-think-with, and should not merely be used as replacements of analog tools.
• School is a laboratory, a studio, and an incubator for students to develop ideas into public-ready products and artifacts, or mimic what professionals create.

Critical Techno Constructivism holds as a central belief that we doom progress and innovation once we insist on reaching an externally defined outcome fed by imported curricular material and strategy; and that at the center of student-driven, problem posing education we must place the computer as an object-to-think-with.

Critical Techno Constructivism asks that educators and students work together instead of at odds in pursuit of real work that has real impact on problems posed and questions asked by the students.

Critical Techno Constructivism operates on the principle that all digital tools must be mixed up with humans and their reality, and that no student should be asked to work at a computer, but rather that people and technology work with each other.

Further, Critical Techno Constructivism was created to undo school as we know it; therefore putting these ideas into action is a conscious effort by the people involved to seek new relationships to knowledge, to seek new innovations that impact their community, to seek new social structures to provide financial freedom, and to counter traditional methods that have been used, consciously or not, for dehumanization.

The externally imposed outcomes for graduation and the rigid rules of college admissions translate into a ready-to-wear experience for most students. Whether or not students understand what they are asked to study is often of little concern. And another test is around the corner. The prescribed curriculum is so normal that it does not faze our sensibilities. Certainly students could learn something they do not previously know or understand, that is not in question, but just what is it that they are learning? Educators discuss multiplicity and diversity in the abstract, but our traditional teaching methods mostly do not help produce diverse and divergent thinkers. We continue to allow predetermined aims and outcomes to take precedence over the experiences and ideations of the child.

Many times the constructivist classroom is seen as a “free-for-all” for those untrained in what to look for when the classroom is de-centered. A teacher evaluator may come in and see that a teacher is not lecturing from the podium or forcing students to move “lockstep” through a downloaded and reproduced worksheet of problems, and for these “crimes” would be considered as going too slowly or not meeting performance standards: one might wonder where exactly this evaluator gets her ideas for what qualifies as quality work happening in school. Nevertheless, these are real glimpses of how schools operate—the fear that a teacher is non-performing has more to do with a misinformed perception of meeting the needs of all students. When the teacher is involved in the process of each student’s pathway in the work, that teacher might be thought of as not teaching, and as strange as that sounds, it is true simply because teacher and administrative training courses do little to provide opportunities to practice anything but traditional methods.

Starving teachers of the opportunity to co-construct experiments with their students robs everyone. To stifle teacher creativity and autonomy can nearly ensure student misery: when the teacher is a lifeless robot, do not expect the students to accidentally find joy in their learning experience. We are suffering from a lack of imagination with how to run our schools, and most “solutions” are attempts to redirect or reinvent a traditional informational instructional model of teaching and learning—we stop short of reinventing school itself.
At the heart of the analyzed works of Dewey, Freire and Papert, is a belief that we always retain a portion of our wonder as children explorers of the world. Through conscious engagement with that wonder and the natural inquiry that ensues, schools have a chance to think with students about knowledge and learning in ways that can reactivate everyone’s excitement for study and production of products or artifacts. The computer is only but a part of this approach and is not where learning ends; the computer is the strongest augmentation tool we currently have available to shift what we do when engaging in learning.

Seymour Papert saw that the default nature of how schools and educators and families think of computers was what doomed its categorical use. Students will, students will, students will—the outcomes and standards are full of sentences about what the students will do but nowhere does it state what the administrators and the faculty will do. Why is this? What promises ought to be made to students about what will be done by the school in their favor? I would like to start right there.

A powerful new classroom space starts to emerge when we rethink the resources and activities with students’ freedom at the center. A class where if you are not wrong you cannot go forward in your work, that is a wholly different model. The trauma of failing in front of your peers would simply not exist because the errors in computer programming are necessary to find useful solutions to build the desired product. Thinking with the computer is considered a radical act, though there will likely come a time in human history that looking back at 2020 will provide a good chuckle at our stubbornness in insisting on a traditional model when we have the tools and philosophies to do otherwise. Included in this paper is an educator toolkit (see Table 1) that will hopefully contribute to accelerating our progress towards new learning theories and schools and experiences for students.

Classroom experiments of this nature could occur globally; the only barrier to entry is the will of one person. The computer is the kingpin in this untethered universe of learning potential for it alone can be used in a manner dreamt up by its user, and the biggest dreamers are children, if we leave them enough space to be just that. It is incumbent upon us to unmask the corporate and political takeover of Education. It is incumbent upon us to empower students and teachers to engage in authentic discovery and study. It is incumbent upon us to transform school in opposition to predetermined outcomes, planned curriculum, and standardized testing.

The fractured curriculum serves the specialist teacher and the accounting system more than it does the student. Freire contends that the fractured curriculum also further isolates people’s minds and prevents them from engaging in the natural play of human imagination and conceptual strength. With authentic dialogue at the center of the work in school, it would be impossible to predetermine the curriculum and the outcomes. Viewing a learning environment in this manner liberates us from the stranglehold of testing and textbook companies. The re-education of the public might need to start right at this point, for it has many far-reaching implications that impact a community. But again, posing school as a problem for a community to solve will allow for the local needs to be heard and addressed. Leadership is essential in the creation of this approach and guidance through it, though that leadership must be of a transformative, not transactional, nature.

My vision for the future is less about using particular applications, clients, programs, and data sets, and more about my desire for the freedom that students and teachers together could have to choose and chart a path. Schools are hanging on for dear life to a traditional model of what Paulo Freire termed “banking education” (an idea that John Dewey wrote about many decades prior) and this is due mostly to how we, in the USA, are still tethered financially to the
Educational Testing Service (ETS). What happens with technology in education or educational technology today is often still recognizable as that which happened since the 1980s — once a week “pull out” computer lab time, individual “one and done” projects, or digitizing work that was previously completed with pencil and paper or typewriters. As of yet, we have not toppled the political money machine that shackles well-intentioned creative people in schools. If we did, and allowed for a shift in graduation outcomes and the manner in which we ask students to engage in work and be assessed, then we would help unleash innovation in ways that we could not predict but would positively change how we think and live.

For future research, I recommend that educators study the students who do not fit the traditional mold and track their progress through colleges and careers. Additionally, I recommend that more research be done on how to create and maintain schools as nurturing places for student engagement, since that is the central component of many pedagogies and theories vying for prominence in traditional schools. And finally, I recommend that we spend time researching how experimental use of computers can augment human thinking. Studies have been performed to demonstrate that an alternative approach via computer programming can produce higher student test scores on traditional assessments than students who covered the material in a traditional manner (Harel & Papert, 1990). But what we have not yet done is to fully explore and study a constructivist, inquiry-based, student-driven computer and computing focus in an academic course.

What happens when we consciously counter the traditional narrative of school and schooling? What happens when students bring their own real-world situations to pose as problems for study? What happens when we make room for student control of the artifacts they produce? What happens when we use computers as objects-to-think-with? What happens when we learn computer programming languages to create software solutions of our own? What happens when we naturally and organically collaborate? What happens when we remove from school the artificial barriers of age grouping, grade levels, time spent, content areas, content sequencing, and testing measurements?

Schools can change. Administrators can change. Teachers can change. Classrooms can change. The students are waiting.
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<th>Tenet</th>
<th>Question</th>
<th>Action</th>
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<tr>
<td>Personal Inquiry</td>
<td>Did the student develop the learning task?</td>
<td>Engage in open dialogue with students with the explicit purpose of developing together new assignments or topics of study. Work with students to define audience, purpose, resources, tools, and goals of the learning task. Think big with students about possible uses and aims of their work beyond the classroom and the confines of school. Encourage students to follow through and develop to its end what they pose as a problem to solve.</td>
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<tr>
<td>Compelling Problem or Question</td>
<td>Did the student arrive at an answer that led to more questions or problems?</td>
<td>Coach students as they work to keep a log of their progress, handwritten, typed, audio or video recorded, for the purpose of tracking ideas as they occur. Encourage students to spot potential new paths or questions to chase as they work. Develop with students some methodologies for addressing conflict and dissonance in their work and studies and possible applications.</td>
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<tr>
<td>Technology as Tool to Think With</td>
<td>Did the student use technology in the thinking process?</td>
<td>Choose technology wisely with students. Remember that analog tools may provide instant freedom in expression. Demonstrate how to think with the computer. Use machine learning, graphical statistics, programming language, and concordances or natural language processing. Make certain the computer remains an object-to-think-with, not a replacement of paper or a push-button terminal.</td>
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<tr>
<td>Formative Demonstration of Learning</td>
<td>Did the student demonstrate learning throughout the process?</td>
<td>Develop guidelines, rubrics, and expectations of outcomes with students. Adjust these as necessary throughout the process of their work, sometimes abandoning them when students find them restrictive. Consult with students about progress and engage in conversations less as an evaluator and more as an interested peer. Sparingly make suggestions so that students retain ownership.</td>
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<tr>
<td>Reflection as Learning</td>
<td>Did the student demonstrate a reflective approach in the formation of knowledge?</td>
<td>Explicitly teach the skills of mindfulness in short lessons. Engage wholeheartedly in the process of looking for student interest and joy in their work. Emphasize to students the importance of caring about their own interest levels. Engage in reflective questions that are genuine. Avoid leading statements about what you would do as this not-so-subtly shows teacher judgment.</td>
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<tr>
<td>Social and Cultural Critique</td>
<td>Did the student demonstrate a critical awareness of the larger established modes and forms of thought that shape thought?</td>
<td>If an understanding of larger social constructs does not yet show in their work, make a weighed decision to point them out. Building consciousness more authentically through self-realization is the most powerful, however, students will need coaching and guiding. Avoid moralizing or hijacking student work with your own politics, values, or experiences. Make mention of historical events, people, or concepts that students might consider for study on their own.</td>
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<tr>
<td>Sharing and Collaborating</td>
<td>Did the student actively seek out collaborators in the process of acquiring knowledge, testing theories, and creating a shareable artifact?</td>
<td>Demonstrate methods, procedures, and styles of communicating with people. Seek out experts and amateurs as guest speakers or consultants. Show the crossover of work done in school and out of school. Practice presentation skills. Create space and time in class to talk together about student progress. Explicitly teach and coach how to communicate respectfully with operationalized critique. Engage with students to develop multiple venues and audiences for sharing.</td>
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References


