Technology Provides Enhanced Capabilities for Educating Learners

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HOW TO CITE THIS ELECTRONIC ARTICLE

Meagan Pollock is a Ph. D. student at Purdue University. This paper fulfills the requirements for
ENE 69500 01: Developmental Theories and Engineering Thinking, Professor Demetra
Evangelou. The anticipated audience for this piece of work will be the executive leadership of
DLP (discussed further in the paper) as a tool to negotiate terms of a co-op for my dissertation
research. Ideally, my intention is for this paper to act as a skeleton for the literature review of my
dissertation. Meagan can be contacted at mail@MeaganRoss.com.

ABSTRACT

Technology provides enhanced capabilities for educating learners, and schools should embrace these capabilities to reshape education and to prepare students for the changing world. Collins & Halverson (2009) identify these enhanced capabilities as "just-in-time" learning, customization, learner control, interaction, scaffolding, games & simulation, multimedia, publication, and reflection. These nine enhanced capabilities were aligned with established learning theories, to link the Collins & Halverson (2009) model with Prensky"s (2008) claim that the role of technology in the classroom can be defined as the tools used to support students teaching themselves. The purpose of this alignment was to support the thesis that *technology provides enhanced capabilities for educating learners.* The development of this thesis aids the stakeholders of education technology in understanding that technology does indeed provide enhanced capabilities for educating learners. Industry leaders such as DLP are specifically interested in how to use this framework to influence student-centered designs of tomorrow"s technologies.

keywords: education technology, user-centered design, learning theories

Introduction

Texas Instruments (TI), a Fortune 500 company based out of Dallas, Texas, is a global leader in semiconductor and educational technologies that are driving profound change. TI takes responsibility for carefully defining the scope, direction and pace of that change ("Corporate Citizen Report," 2008). TI's founders decided that the company's worth was based not only on the strength of its balance sheet, but also on its contributions to society. This philosophy became a foundation for all operations and is still evident today in their ongoing efforts to improve education, the environment, and quality of life for their employees, neighbors and communities ("Corporate Citizenship Report: Community," 2010).

TI first reached into the consumer market in 1967 and transformed math and science education with the invention of the handheld electronic calculator. In 1987, two professors, Frank Demana and Bert Waits, from Ohio State University contacted TI, and other companies, to discuss their ideas of using graphing calculators in pre-calculus classes. The professors explained that most students didn"t have access to computers and graphing calculators could be an ideal solution if made easier to use. Demana and Waits were impressed that TI, more than any other company, were willing to take a chance on their idea. TI began working with the professors and other math educators "to design and develop a unit that would be simple to use, yet incorporate all of the features required by math students (Pirtle, 2005).

Within four years, a graphing calculator was introduced that helped students visualize abstract concepts. TI became well known throughout the educational community because they reached out to teachers like no other company in the market had ever done before. TI hosted workshops to learn from educators and to help them effectively use the technology in the

classroom. The ideas assimilated from the workshop would go on to inform future versions of the graphing calculators, as well as other educational technology. The graphing calculators have continued to evolve, and "many teachers, scholars, and textbook publishers are developing curriculum that [directly] integrates the use of the TI graphing calculator into everyday lessons (Pirtle, 2005)." TI"s connection with the education community has ultimately led to the company"s achieving a greater market share of the graphing calculator market (Pirtle, 2005).

The graphing calculator wasn"t TI"s first foray into user-informed design for educational learning aids. In 1978, a personal, portable, and digital device called the Speak & Spell™, the first consumer product to utilize digital signal processing technology, was released to help preschool through third grade students increase their vocabulary. Project leader Gene Frantz worked with consumer focus groups to develop the right voice and to research word lists to be used on the Speak & Spell. The success with this product allowed TI to expand their educational products to Speak & Math, Speak & Read, and Speak & Music, along with a collection of speaking children"s toys that were sold worldwide – in several languages (Pirtle, 2005).

DLP Products

DLP technology from Texas Instruments (TI) is a precise, digital imaging chip that powers today"s best projectors, HDTVs, Digital Cinema systems and other sophisticated devices for medical, printing, security and more. The DLP chip consists of up to millions of tiny, microscopic mirrors which reflect light, digitally to create an image. First available in projectors in 1994, DLP technology now powers virtually half of all new projectors worldwide ("How DLP Technology Works," 2010). In 2009, with new leadership, DLP formed a new market division within the business focusing on education. DLP hopes to find the success of it"s educational

technology predecessors at TI. The reorganization of DLP targeting the Education Market is aligned with TI‟s values and priorities, and addresses a large market opportunity.

Landscape for Educational Technology

A 2007 Datamonitor reports claims: "The landscape for educational technology is evolving rapidly in the education market. The global marketplace offers new opportunities for vendors serving education institutions. The competitive landscape for educational technology represents an appealing prospect for vendors." In fast growing countries like India, the yearly education market is worth billions ("K12 Education Market in India," 2010). In the United States alone, school districts reportedly spent $7.87 billion on technology equipment during the 2003–2004 school year (Quality Education Data, 2004). A 2005 report by Datamonitor states: "While the US education market will increase ICT [information and communication technology] spending over the next five years, the buying preferences of educators will shift as they seek to use technology as a tool to improve performance and demonstrate value. Vendors will need to offer more robust and compelling solutions to education institutions in order to be successful in this increasingly sophisticated market."

DLP is finding success marketing products from the current design portfolio, however there are few specific designs targeting the Education Market. In order to revolutionize DLP products to capture this expanding market, research is needed to explore what is needed and wanted in the classroom environment. DLP is interested in changing their business model to a more user-centered design, following the footsteps of TI‟s previous educational products. User-centered design (UCD) is an approach to design that grounds the process in information about the people who will use the product. UCD processes focus on users through the planning, design

and development of a product (Abras, Maloney-Krichmar, & Preece, 2004). The process of user centered design challenges the researcher to examine and study each of the stakeholders of the potential product. For an education product, these stakeholders may include, but are not limited to: students, teachers, school administrators, parents, the engineering team, and the business. DLP would like to be ahead of the curve, addressing the needs of the current and future learning environment, all the while specifically considering the primary users.

Students in this age of technology are learning differently than those that came before them. "The very concept of an „education‟ is changing for many kids, as they experience self-directed learning, mostly out of school, about things that interest them, and they see how different this kind of learning is from the „push it on you‟ and „test you to death‟ methods of formal schooling (Prensky, 2007)." Oblinger (2003) writes, "Some general trends are emerging about how learners view technology. Not surprisingly, technology is assumed to be a natural part of the environment. The younger the age group, the higher is the percentage who use the Internet for school, work, and leisure. This comfort with technology often leads to a perception that the use of technology in schools is inadequate." Students today are so accustomed to using technology in their daily lives, that they are eager for similar technologies to be used as a part of their education, in part because they‟ve already mastered the technology, or in part that they realize just how useful the technologies can be (Prensky, 2007).

Knowledge Revolution

Technology has permeated our lives. The International Association for Wireless Telecommunications Industry (CTIA) reports that as of December 2009, 91% of the U.S. population carries a mobile phone. These mobile phones, however, are much more than a calling device. Mobile phones today have integrated technologies to create the ultimate personal digital assistant including a camera, video recorder, mp3 player, digital equivalent of a rolodex, electronic calendar, projector, GPS tracker and map tools, banking, email, and not to mention all of the search benefits of the Internet. To many, these phones have become a lifeline to information about anything, anytime, and almost anywhere. Just as our country experienced the Industrial Revolution in the 19th century, we are now going through another revolution of a similar scale: the Information Revolution. Cell phones, Internet, video games, and personal computers contribute to what is also called the Knowledge Revolution. "While the imperatives of the industrial-age learning technologies can be thought of as uniformity, didacticism, and teacher control, the knowledge-age learning technologies have their own imperatives of customization, interaction, and user-control (Collins & Halverson, 2009)."

The paradigm in K-12 education is shifting from the "old" pedagogy of teachers lecturing, to the "new" pedagogy of students teaching themselves with the teacher's guidance (Prensky, 2008), a parallel to Collins & Halverson's definitions of the industrial and knowledge-age learning technologies. Prensky (2008) writes that with this paradigm shift as our goal, the role of technology in the classroom can be defined as the tools used to support students teaching themselves. When technology is used with the "old" pedagogy, it more often than not just gets in the way.

Alternative views do, however, prevail, and Mark Prensky highlights three examples in his paper on *The Role of Technology:*

Some school districts added technology (e.g. by giving laptops to all students), but did not find that the technology was helping the kids" learning, and so took it out ("Seeing No Progress, Some Schools Drop Laptops" The New York Times, May 4, 2007.) This now makes sense – the district didn"t first get all the teachers to change the way they taught.

Many teachers resist being taught to use technology. This also makes sense – teachers should resist, because it is not they who should be using the technology to teach students, but rather their students who should be using it, as tools to teach themselves. The teacher"s role should not be a technological one, but an intellectual one – to provide the students with context, quality assurance, and individualized help.

Students routinely "abuse" (from the teachers" point of view) technology in class, using it, as one professor says, as "the new spitball." This, too, makes sense – kids have in their hands powerful learning tools that they are being given no opportunity to use to learn (Prensky, 2008).

Collins & Halverson (2009) argue that new technologies will revolutionize schooling in this changing world. They make their case for technology by exploring nine enhanced capabilities for educating learners in *Rethinking Education in the Age of Technology*. The Collins & Halverson model of enhanced capabilities coupled with Prensky"s claim that the role of technology in the classroom can be defined as the tools used to support students teaching themselves yields the thesis: *technology provides enhanced capabilities for educating learners.* By aligning established learning theories with this joint model, the thesis will be supported and

may provide a framework for DLP to apply a user-centered-design approach for education

products, thus creating highly marketable technologies that specifically enhance education.

Enhanced Capabilities for Educating Learners

The purpose of this section is to identify the convergence of each of Collins & Halverson nine

enhanced capabilities for educating learners with Prensky"s claim that the role of technology in

the classroom can be defined as the tools used to support students teaching themselves is an

established learning theory (

Figure **1**).

Figure 1 Learning Theory Convergence of Collins & Halverson (2009) and Prensky (2008) models
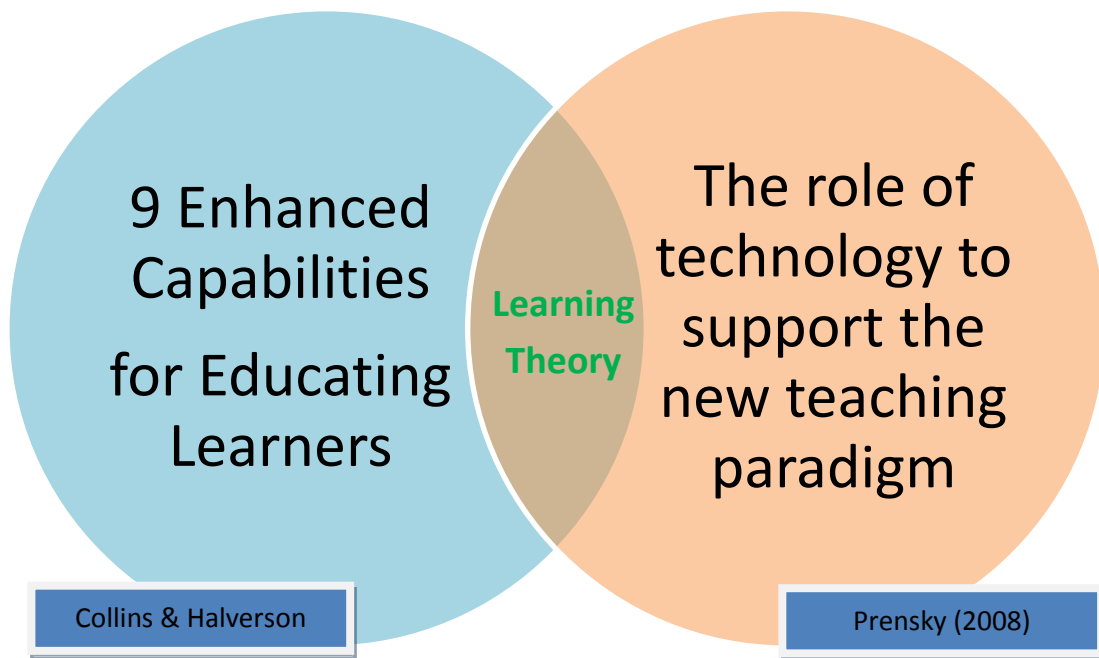
"Just-in-time" learning

"The notion of "just-in-time" learning is that whenever you need to learn something in order to accomplish a task, you can find out what you need to know (Collins & Halverson, 2009)." Instead of memorizing historical dates and scientific phenomena, "just in time" learning finds it is more important to develop the skills to ask the right questions to find the right information whenever it is needed. Just in time learning attempts to tie what is learned to its use in the world, a more skill based than a fact based approach. Prensky (2008b) contrasts this in his article on "Backup Education." In his interface with educators, their concern was what to do when technology fails.

> "What the teachers are really saying is this: "We don't trust the technology of today, or the future. We don't trust the world in which you kids are going to live. We believe the way we did it in our time was the "real" way, the only reliable way, and that's what we want to teach you kids – "the basics (Prensky, 2008b)."

These teachers are advocating teaching not "the basics" but a "backup" education of old methods, ones that are useful in unlikely emergencies.

J. Sweller's Cognitive Load Theory supports "just-in-time" learning. A problem solver who's entire cognitive processing capacity is devoted to goal attainment leaves no capacity to be devoted to schema acquisition (Sweller, 1988). This builds on George Miller's research (1956) that our short-term memory could only hold 5-9 chunks of information (seven plus or minus two) where a chunk is any meaningful unit. Any student can memorize historical dates to regurgitate on an exam, but is it really an enduring understanding? Two decades ago, the common forms of information were textbooks and encyclopedias. With the wealth and breadth of information

available on the Internet, learning how to inquire, where to look, and the big concepts around the idea is a more valuable tool for a student in the age of technology. Instead of the teacher lecturing on the economic impacts of the Holocaust, the teacher can challenge the students to use their technology to search for answers, and follow-up with a class discussion. This student-guided approach to learning can enable better cognition and retention.

Customization

"One of the major effects of technology proliferation has been the ability to cater to individual preferences (Collins & Halverson, 2009)." Amazon.com is able to index a shopper's purchases and compare it to similar shoppers, thus recommending other items that might be of interest. Tivo, a digital TV recording device, can "remember" the shows that the user views and recommend other similar shows. Stallard and Cocker (2001) have envisioned that students will eventually have their own computer based learning assistants, which can store records about their learning history in order to guide their learning. With a program like this, Vygotsky's zone of proximal development (ZPD) can constantly be evaluated and adjusted in order to provide the appropriate scaffolding for learning. Vygotsky (1978) defines the ZPD as the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers." Like the intuitive computer programs that "know" the user, technology has the potential to specifically customize learning for each student, a task that is merely impossible for a teacher with a large class.

Learner Control

Technology "enthusiasts argue that as new technologies, like the printing press before them, enable people to take control of their own learning, people decide what would be valuable to them and what they want to learn (Collins & Halverson, 2009)." Before the invention of the printing press, what people learned was controlled by those who had access to the information. Similarly in schools today, educators control what people learn by defining the curriculum.

Learner control is directly supported by Bruner's constructivist theory, in that learning is an active process where learners construct new knowledge based on their previous knowledge. The learner's readiness to learn informs what they deem to be valuable and of interest to learn (Bruner, 1966). This directly supports Prensky's (2008) claim that the role of technology in our classrooms is to support the new teaching paradigm, where students teach themselves with the teacher's guidance.

Interaction

"By providing even more sophisticated dynamic interaction, computer-based learning environments are likely to make education much more engaging (Collins & Halverson, 2009)." Prensky (2007b) describes kids today:

Today's kids hate being lectured to, but what do they want from their schools? The answer, they tell us, is community. Working in groups. Doing projects. Having the opportunity to share their ideas with their peers and hear what their peers have to say. Being challenged. Being asked interesting questions (Prensky, 2007b).

Interactive inquiry based learning is based on the early constructivist theorists such as Bruner, Dewey and Piaget. Dimitrios Thanasoulas writes, "It is the learner who interacts with his or her environment and thus gains an understanding of its features and characteristics. The learner constructs his own conceptualizations and finds his own solutions to problems, mastering autonomy and independence. " Autonomy and independence are characteristics of the Deci & Ryan's self-determination theory which when encouraged by a teacher can result in intrinsically motivated learning (Deci & Ryan, 1994). Experiential learning theory defines learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience (Kolb, 1984)." Computer based learning environments that facilitate inquiry and experiential learning within a community can yield engaged learners, and potentially intrinsically motivated students.

Scaffolding

"Scaffolding enables learners to carryout tasks that are beyond their capabilities (Collins & Halverson, 2009)." It is a support system that is designed to gradually fade away as the learner needs less and less assistance. For example, many computer games are structured to allow the player to ease into complex tasks through scaffolded techniques. Individualized scaffolding reiterates the value of the customization of technology as an enhanced capability to educate learners. Scaffolding Theory was first introduced in the late 1950s by Jerome Butler.

Games & Simulation

"Computers enable technologists to create scenarios where learners are given tasks in simulated environments that embody the kinds of knowledge and skills the learners will need in

the real world (Collins & Halverson, 2009)." Games and simulation echo the learning theories discussed in the enhanced capability of interaction.

Multimedia

"Enthusiasts assume that all of the different media will play a role in the design of learning environments. These different media can enhance learning by addressing the different learning styles and abilities of students and by using the media that are most appropriate for the material to be learned (Collins & Halverson, 2009)." Bandura"s social learning theory can be related to multimedia as an enhanced capability of technology to educate learners. Bandura (1977) states: "Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action."

Publication

"As student work matures, students need opportunities to demonstrate their learning in legitimate contexts outside the classroom (Collins & Halverson, 2009.)" The Internet is the primary example of such an outlet that allows the student to contribute to a larger community and receive feedback. J. Lave"s situated learning theory requires social interaction and collaboration for learning to take place. As summarized on Greg Kearsley"s Theories Into Practice Database:

Social interaction is a critical component of situated learning -- learners become involved in a "community of practice" which embodies certain beliefs

and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its center, they become more active and engaged within the culture and hence assume the role of expert (Kearsley, 2010).

The internet and other media provides students ample opportunity to engage in "communities of practice" and thus learn through social interaction and collaboration.

Reflection

"Reflection occurs when learners look back on their performance in a situation and compare their performance with some set of standards or with other performances, such as their own previous performances and those of experts (Collins & Halverson, 2009)." The Transformational Learning Theory originally developed by Jack Mezirow is described as being "constructivist, an orientation which holds that the way learners interpret and reinterpret their sense experience is, central to making meaning and hence learning" (Mezirow, 1991). Meaning structures, a major component of the theory, are understood and developed through reflection.

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Conclusions

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Technology provides enhanced capabilities for educating learners, and schools should embrace these capabilities to reshape education and to prepare students for the changing world. Collins & Halverson (2009) identify these enhanced capabilities as "just-in-time" learning, customization, learner control, interaction, scaffolding, games & simulation, multimedia, publication, and reflection. These nine enhanced capabilities were aligned with established learning theories, to link the Collins & Halverson (2009) model with Prensky"s (2008) claim that the role of technology in the classroom can be defined as the tools used to support students teaching themselves.

The purpose of this alignment was to support the thesis that *technology provides enhanced capabilities for educating learners.* The development of this thesis aids the stakeholders of education technology in understanding that technology does indeed provide enhanced capabilities for educating learners. Using this thesis as a framework for student use of technology and learning, DLP can implement a user-centered-design approach for education products, thus creating highly marketable technologies that specifically enhance education.

Limitations & Future Work

A more in depth examination into the enhanced capabilities of technology for educating learners would look further than just the Collins & Halverson (2009) model and would relate more learning theories and the specific impact of each for learners. For this thesis, the Collins & Halverson (2009) model was used as an outline to portray the importance and impact of educational technology for educating learners. Whereas the case for constructivism and self guided learning has been established, it was only briefly referenced in this paper. Future work may consider integrating this case to further support the thesis.

Significance & Call to Action

The leadership of DLP has posed a question: if we understand how students learn, how can we create the products of tomorrow to enhance learning, today? Given this gap in the current research within DLP Education business model, I would like to propose a cooperative education opportunity focus on user-centered design of DLP products within the K-12 setting. This model of cooperative education would be a three-way partnership between the employer, the student, and the University. The agreement would be that my research while employed as a co-op student

would align with both DLP business objectives and my research objectives, and that I will focus on a single major project to serve as my dissertation study.

After completing my Ph. D. in Engineering Education from Purdue University, my goal is to return to industry in a role that allows me to integrate my knowledge of engineering education research and design methodology, yet still enables me to practice as an engineer. Some call this type of role a "Human Factors Specialist" which would lead teams through inspiration-gathering and people-understanding experiences to uncover stories and insights that help guide and influence design and innovation. Given my 18 months of product engineering experience working at DLP and my passion and interest in DLP"s technology, I naturally considered DLP first for a co-op/dissertation partnership.

This is a call for leadership to follow in the footsteps of TI innovators such as Gene Frantz. We can partner to innovatively impact the DLP design model in a way that proves profitable in the education market, similar to that of the TI graphing calculator. If this model proves effective, it could potentially be applied to all markets. DLP has been a leader and an initiator of change among TI businesses, and with this opportunity to partner in a study of user-centered design, DLP can continue to forge the way.

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