Towards a Framework for Analyzing and Implementing 21st Century Teaching and Learning with Attention to Educational Reform

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Abstract: This paper proposes a framework for analyzing 21st century teaching/learning attentive to implementation and educational reform. While teaching, curriculum, school cultures, school structures and support for schools require revisiting assumptions to improve student learning as we move through the 21st century, gaps exist in calls for implementing 21st century learning. Based on my experience working in schools as educator and technology professional, I am proposing an exploratory framework to assess implementation of 21st century learning by considering educational value, benefits and economic plausibility of proposed changes. This paper contributes a preliminary review of the literature with a summary of a number of 21st century positions, with a framework to assess implementation by considering new literacies, digital divides, teacher training, and curriculum reform. Given the foundational nature of the framework I am proposing, this paper carries implications for administrations, technology support professionals, district coordinators, teacher educators and classroom teachers.

The proliferation of groups and individuals calling for reform in education makes distinguishing between new ideas, relabeled failures, and rhetoric challenging for both educators and the general public. Many recent calls for reform have labeled themselves as 21st century schools (Jerald, 2009), 21st century learning (Partnership for 21st Century Skills [21P], 2007; Abbot, 2007), 21st century competencies (European Commission [EU], 2003), 21st century skills (Educational Testing Service [ETS], 2003), new millennium schools (Pedró & Tømte [OECD], 2008), classrooms of the future (Wyer, 1994), or some other variation on this theme[1]. Most of these groups (21P, American Association of Colleges and Universities [AACU], Metiri (2003), Jerald, EU and OECD) cite changes to employers job skill requirements because of the rapid pace of change in our societies and ongoing globalization as motivation for change. These reforms are calling for changes to not only what is taught, but also to how teaching is carried out, with calls to move to constructivism and a more technological focus the most common.

Bill Gates described a pyramid with four general layers, from bottom to top: hardware, operating system, (programming) language and application (Feng, 1996). Over the past decades each layer in turn held the focus of attention of users, educators and the public. Those with extensive experience in ICT will recall personal computers from the 1970's as hardware without much else. During a focus on the hardware level companies shipped computers to schools with little or no software available. In the early 1980's IBM and Microsoft brought clarity to the muddle of multiple hardware and operating system platforms with the PC and MS-DOS, and GW-BASIC made available a programming language usable across multiple hardware platforms. Apple's Macintosh brought graphical user interfaces to the forefront in the late 1980's. Windows gained prominence in the early 90's, when operating systems often solely decided new computer acquisitions. The Internet brought us multiple new and novel ways to use computers along with an explosion of new programming languages. Java brought us platform independence. Throughout these changes there is one clear and consistent thread – the bottom layers of the pyramid shrank while the upper layers grew.

The 80s focused on hardware, the 90's focused on operating systems, with Microsoft winning the platform wars. As the platform wars wound down and Internet usage grew, programming language numbers increased greatly. We currently have multiple platforms; smart phones, tablets, and multimedia devices joined our desktops, laptops and netbooks. Handheld devices caused unprecedented application growth – in May 2011 there were 390,000 iTune applications (Om, 2011), and in Oct 2011 Apple claimed to have over 500,000 applications available for download (Apple, 2011), phenomenal by any measurement.

This trip down memory lane serves to remind us of technological change, the difficulties involved in planning and implementing change, and how changes involving technology are magnified because of technology's

[1] Abbreviations in square brackets will be used in place of full names throughout rest of paper

power. Technological change often involves changes to culture (Monahan, 2006), and because they affect the whole system, need implementing using Fullan's (2010) whole system reform model.

This paper seeks to bring clarity to the muddied waters of these multiple call for 21st century learning implementations by identifying and summarizing relevant groups' positions, identifying gaps and proposing a framework to analyze reform calls.

Summaries of Prominent Groups and Individuals

A. Partnership for 21st Century Skills (21P)
   i. Summary: 21P seek to ensure student's readiness to be productive members of society after graduation. Their framework uses a core of traditional subject area knowledge and adds skills and expertise in areas they define as being critical for success in life in a highly technological society. 21P have a well defined and thorough framework that includes support systems for schools and teachers, professional development and considers school and classroom environment. (21P, 2007; Mishra & Kereluik, 2011).
   ii. Main concern: economic wellbeing of western nations
   iii. Main Impact: diminishes traditional subject area knowledge and increases importance of skills; wholesale changes to schools and the curriculum and how professional development is carried out

B. American Association of Colleges and Universities (AACU)
   i. Summary: AACU's framework defines goals and outcomes for college education in the 21st century. The framework includes building and acquiring knowledge of human cultures, the physical and natural world, intellectual and practical skills, personal and social responsibility and integrative learning. (Mishra & Kereluik 2011)
   ii. Main Concern: economic wellbeing of USA, a need to take advantage of technology in education.
   iii. Main Impact: diminishes traditional subject area knowledge and increases importance of inter-societal knowledge and critical thinking and problem solving

C. Jerald
   i. Summary: Jerald claims employment success hinges upon possessing complex communication skills, non-routine skills, self reliance, and the ability to work well unsupervised, all because of globalization and automation of physical and cognitive tasks. His framework divides knowledge and skills into foundation, practical literacies, and broader competencies areas, but stresses knowledge and skill work together. (Jerald, 2009)
   ii. Main concerns: economic future of western countries, especially the USA
   iii. Main impact: replaces high stakes testing with realistic assessments; strengthens preparing for post secondary education; adds new skills and knowledge to curriculum without dropping content

D. Educational Testing Services (ETS)
   i. Summary: ETS' framework redefines Information Communication Technology (ICT) literacy and calls for a revitalized integrated ICT curriculum with assessments which target competencies in ICT as well as other domain knowledge. Their call for change is based on their definition of digital divide: those with skills to make use of technology and those without. They promote Accessing, Managing, Integrating, Evaluating and Creating as key components of ICT literacy, but also stress the need for parallel cognitive development. (ETS, 2007)
   ii. Main concerns: economic future, ICT competency
   iii. Main impact: transforms assessment practices, integrates ICT and redefines literacy to include new technologies

E. Organization for Economic Cooperation and Development (OECD)
   i. Summary: OECD's globalization and modernization research identified "key competencies". Their framework separates skills and knowledge into 3 realms: using tools interactively, working in groups, and acting autonomously. They place importance on reflective thought and action, and interconnect their three realms and justify their position because of the complexity and challenges of the modern, technological world. (Pedro & Tomte, 2008; Mishra & Kereluik, 2011)
   ii. Main concern: economic wellbeing
   iii. Main impact: makes skill more important that subject area knowledge; stresses "reflective thought", which appears to be synonymous with critical thinking

F. International Society for Technology in Education (ISTE)
   i. Summary: ISTE's standards include skills they claim to be crucial for lifelong learning and productive global citizens: creativity, innovation, communication, collaboration, research, critical thinking, problem solving and effective and efficient technology use. To them, technology literacy includes systems knowledge along with the ability to apply knowledge in a meaningful way. (Mishra & Kereluik, 2011)
   ii. Main concerns: globally competitive workforce, underuse of technology in education
   iii. Main impact: teaches tech skills earlier making them ubiquitous; adds creativity, problem solving, communication and collaboration as clearly stated and assessed curriculum goals.

G. Metiri Group
   i. Summary: The Metiri group posits today's proliferation of technology offers opportunities for economic and civic improvement and requires a shift from "plateaus of knowing" (Metiri, 2003, pg. 2) to continuous cycles of learning. Their four areas of skills development (digital age literacy, inventive thinking, effective communication, and high productivity) surround and support academic achievement. They espouse authentic learning which engages students in real world experiences. (Metiri, 2003)
   ii. Main concerns: economic wellbeing of western nations
   iii. Main impact: shifts focus from the academic core to their "21st Century Skills"; changes students learning experiences.

H. Council of the European Union (EU)
   i. Summary: The EU's policy paper claim globalization and knowledge economies change key competency requirements for lifelong learners. Their call for change includes main stream and higher education and workplace training, focusing on ICT in all areas. Some of their calls for change are an effort to make teaching a more attractive profession. (EU, 2003)
   ii. Main concern: economic well being to meet specific economic, social and environmental goals
   iii. Main impact: moves education away from knowledge delivery toward life-long learning teaching styles, increases ICT emphasis

I. 21st Century Learning Initiative (21CLI)
   i. Summary: 21CLI's purpose is to facilitate the emergence of new learning approaches drawing upon a range of insights into the human brain, the functioning of human societies, learning as a community-wide activity. They believe their approach nurtures and forms democratic communities worldwide, and will helps reclaim and sustain a world supportive of human endeavor. (Abbott, 2010)
   ii. Main concern: how students learn, how we teach
   iii. Main impact: new and refined teaching methodology

All groups summarized, except 21CLI, assume an expanding information society leading to future economic failure without educational reform and pay little attention to improving educational system effectiveness and efficiency. Many of the proposals put forward increase the amount of knowledge students would need to acquire in their school years, but neglect to address improvements to learning efficiency. This paper does not seek to attack the assumptions inherent in most of these groups' positions, nor does it seek to discredit any of the groups calling for reform, rather it seeks to set out a framework to assess the overall educational value of a call for reform.

A gap exists in literature critically examining these groups' proposals. Opinion and rhetorical articles abound, yet few quality articles seem to exist, hindering even a brief literature review. Four articles were found which summarized or attempt to justify "21st century" learning (Dede , 2010a; Dede, 2010b; Mishra & Kereluik, 2011; PPRC, 2010). These articles, while contributing to the discussion, illustrate the shortcomings in the body of literature, and fail to identify gaps in the reform proposals. Gaps exists in areas of seeing the teacher standpoint; scaffolding the learning; how and when to teach the technology. Little attention is paid to a new digital divide. The reforms also fail by addressing only the application level, by seeing curriculum as lists, and by paying little attention to their economic feasibility. Lastly, the literature often trivializes the problems, perhaps to increase plausibility through simplifying proposed reforms.

The Framework

Dede (2010b) put out a call for metrics; a call for parameters to measure usefulness and successes of 21st century learning, a call for a measuring stick of the success of implemented changes, but there is a real need for a

measuring stick to evaluate proposed reforms before implementing. This section of this paper outlines such a framework, a framework for assessing proposed reforms to determine if they are valuable enough to spend the time and money to implement. This framework calls for reforms to provide learning advantages, to examine curricula as a grid, to address the digital divide and new literacies, to build in teacher training, to not repaint existing practices as new ideas, to protect teaching and learning of reading, writing and arithmetic, and to enable changes to technology support models.

New Ideas Needed

Dede (2010b) discusses changes being in kind or in part. A change in kind is a change that introduces something completely new, something that was not possible to do previously, usually brought about because of new technology. A change in part is a change that is an extension of something that is already being done. There is nothing truly profound about changes in part – moving from one writing tool to another is not groundbreaking, nor likely nearly as important to a learner as learning to write. Reforms comprised of changes in part are not needed, as these changes will occur as learners and society evolves, much like the evolution from quills to fountain pens to ball point pens, changes that occurred not because a group believed ball point pens gave learning advantages to students, but because ball point pens became the common tool for writing.

Reform, to be accepted and adopted, must propose real change. For example, most 21st century learning proposals express the need for students to have critical thinking and problem solving skills, but all disciples already include problem solving and critical thinking as part of their underlying curriculum. Students cannot achieve in Mathematics, Chemistry or Physics without learning problem solving. Students cannot achieve in History or Literature without thinking critically. Reform must not hinge upon bringing to the forefront what is already being done; that is not reform, that is a minor adjustment.

Reform therefore must not only be comprised of reorganizing existing goals, or extending what is already being done, but must introduce something new.

Learning Advantages

A proposed reform must offer a learning advantage to the learner. This advantage must be either effective or efficient or equip the learner with skills or knowledge they need in their everyday life. The measure of need must not be only economic. While we know earning a living is important, and we want graduates to be equipped as best they can be, the efficacy of teaching specific workplace tools or techniques to students many years before graduation is questionable because those tools and techniques may be obsolete when students finally enter the workforce. If a learning tool or technique increases the rate of learning, it increases efficiency. If a learning tool or technique increases the amount learning of students, it increases effectiveness.

Reform must therefore focus on improving the effectiveness and efficiency of student learning.

Curriculum as a grid

Traditionally curricula are lists of achievements, learning outcomes or goals, perhaps with tables or multiple columns delimiting grade or achievement levels. The necessity of intertwining reading levels with other subject levels is often acknowledged, but curriculum is rarely seen as a grid of knowledge and the skills needed to exemplify or perform that knowledge. Mastering science is not just building the knowledge of science; it involves gaining various skills such as problem solving, measuring, following directions and performing calculations. Gaining skills without context is inefficient; the skills need to be gained in context of building knowledge. As more technological tools are available for students, more focus is on students gaining skills to use those tools efficiently, but to use those tools effectively, they must be used to build authentic knowledge (ISTE, 2007) or in authentic learning performances.

Life is not delimited as nicely as curriculum. School subjects are often silo in nature, appearing to be self contained and not influencing or being influenced by other subject areas. The boundaries between science, social studies, mathematics, and language arts are not nearly as definitive as they are in curricula lists; curricula structured as a grid with inter-subject area outcomes enriching student learning, and including the skills required to build and perform that knowledge would make learning more authentic and real-world.

Reform therefore must focus on building a curriculum grid which intertwines subject knowledge and skills.

Addressing the Digital Divide

The traditional digital divide is growing (Kozma, 2010) and changing from a lack of hardware to a lack of technical skills (ETS, 2007). Van Dijk & Hacker's (2000) digital divide is based on access; individuals with least access become the least technologically skilled. However the digital divide is defined, the gap is not truly bridged

until technology is used efficiently and effectively. In other words, putting hardware in the hands of a learner does not bridge the digital divide; the gap is only bridged when the learner has acquired the skills and knowledge to use the technology effectively and efficiently.

As the technology pyramid increasingly inverts focus on the application level increases, resulting in calls for reform focusing almost completely on that level and contributing to increasing Kozma's and van Dijk's digital divides. Knowledge of operating systems, programming languages, and hardware remain important, and without continued scrutiny and attention from learners, those layers will contribute to a larger digital divide where few will have the skills and knowledge to assess impacts of hardware, operating system, or programming language changes. The computer industry is still in its infancy, yet educators are trivializing important areas in this industry by focusing on the application level. In order to combat continued fracturing and growth of the digital divide, reform must take care to include all technology layers.

Reform therefore must acknowledge and deal with an evolving and growing digital divide.

New Literacies

New technologies may give birth to new literacies, and there is ample discussion in the literature on this point. ETS (2007) articulates an ICT literacy continuum from accessing to creating. Jenkins (2006) lists new literacies of play, performance, simulation, appropriation, multitasking, distributed cognition, judgment, transmedia navigation, networking and negotiation, but is adamant the old literacies of reading and writing will not disappear. Jerald (2009) suggests literacy as traditional reading and writing was always insufficient because it did not encompass different applications of reading. Jerald sees a need to address scientific, technological, mathematical, and civic literacies. Gardner's (2008) disciplined, synthesizing, creative, respectful and ethical minds can be viewed as literacies.

New literacies should not be trivialized, but also need to be changes in kind, and not changes in part. Focusing concern on comprehension differences in reading from a book and reading from a digital device, be it handheld or large screen, misses the mark. Jenkins' literacies are not truly new, as people have been engaged in those activities (with the possible exception of transmedia navigation) for centuries. However, ICT magnifies the importance of Jenkin's literacies and enables students to engage in them in schools. Jerald's literacies and Gardner's minds are also not truly new, but again have been made more important because of ICT.

Jerald's technological literacies need to be considered thoughtfully. There appears to be a need for schools to take on the role of teaching etiquette of conversing using the technologies of cell phones, instant messaging, social media sites and email. Technology literacy needs to get below the application layer to include operating system and hardware layer knowledge.

Wesch (2010) tells us connecting, sharing, organizing, publishing and collaborating is now "ridiculously easy" (Wesch, 2010, 3:38). When adopting new literacies, we need to acknowledge this fundamental change in the world around us. From ETS's continuum and other groups' views, it is clear educational reform must include a new definition of literacy to recognize the importance of performing, playing, creating and being ethical and respectful. Perhaps students should not be considered literate unless they are fluent in communicating with others in a manner that is respectful and ethical using all common communication tools available. As with the curriculum as a grid, this definition is multidimensional, includes paper and electronic written, verbal, and video communication, expects disciple specific vocabulary, and allows collaboration.

Reform therefore must include a new definition of literacy.

New Teacher Training

There are huge implications to adopting many proposed reforms. One implication of increased reliance on ICT is the need for teacher training in ICT. For teachers to be effective and efficient technology users they need to be knowledgeable about the technology, at as many layers as possible. Teachers also need the ability to distinguish between required, optional or unneeded ICT use by students. Teachers need to become technological power users to best take advantage of the power technology offers.

Most proposed reforms include increasing the use of constructivism, moving from the teacher as the source of knowledge to the teacher as a guide and companion on a journey of knowledge building. Constructivist research suggests learning is more effective if students work on real world problems and through cooperative, collaborative group projects (Bonk & Cunningham, 1998). Thomas (2000) indicates teacher support must be provided for the constructivist classroom to be effective. Teacher training and support will be needed to carry out the teaching the reforms call for.

Reform therefore must include teacher training and support for new teaching strategies and new ICT.

Change Technology Support

Schools endure thin technology support, technological change without mandated training, and attitudes of technology use as beneficial but not required. In this century, technology literacy has heightened importance (Dede, 2010b; Jenkins, 2006; Kozma, 2003), and device types proliferate. As with all areas of reform, to be successful, support for the underpinning, for the scaffolding, is needed. To support increasing technological literacy and teacher technology skills, new models for technology support will be required. Educational technology use is decidedly different from corporate technology use, and technology support should not follow a corporate model. Schools and school districts need technologically knowledgeable educators, not technology professionals, in oversight positions.

Education, not security, should be the main concern of technology support teams. For example, teachers need to test out hardware and software and students need freedom to explore sites and applications that are not necessarily on a pre-approved list. This is not to say care need not be taken and security not considered, rather the priority of technology support must be teaching and learning. Security of data and networks and the safety of students should not be compromised, yet many strategies used by technology support teams are in place to make the technology support teams' job easier, not to the make networks more secure, and decidedly not to make a teacher's job easier or to improve learning efficacy.

Reform therefore must include changes to technology support models in schools.

Keep the three R's

One fundamental purpose of school is to teach students to read, write and perform basic arithmetic. This purpose is as important as ever, and should not be marginalized in any way. ICT could allow students to navigate through school without learning to read, write, or understand little more complicated than counting and the concepts of arithmetic. Students need the ability to function without ICT, as it will surely fail at some point, as much as they need to function with it. Much writing is still in printed form; not teaching reading could isolate students from those writings, taking away opportunity to grow beyond what others have seen fit to digitize.

Reform therefore must not marginalize the three Rs.

This framework, as it currently stands, draws upon current practices yet seeks to bring a foundational shift by clearly defining a number of areas that are interrelated yet are currently somewhat fragmented in practice, and attempts to do so without rhetoric and without political considerations, while aspiring to support the realities of the 21st century. By keeping the foundations of reading, writing and arithmetic, by including the disadvantaged and the teacher, and reorganizing curricula, the framework seeks to be attainable yet dynamic. By ensuring changes are real, provide improvements to learning, and address new literacies, the framework seeks to be extensible. By valuing teacher training and revisiting technology support, it seeks to be empowering.

Implications

There are a number of implications inherent in this framework. Reforms need to be new and show the promise of improved student learning because of improvements in efficient and effectiveness, without a promise of improved results on standardized assessments. Reforms cannot replace critical content learning outcomes with other learning outcomes. Authentic learning focuses on complex real world problems, is cross disciple and utilizes multiple habits of mind and is community oriented (Lombardi & Oblinger, 2007). After reform, learning will be more authentic than what currently exists. Reforms need improved infrastructure to support the new technologies and technologies of the future.

There are also implications to how schools are managed after reform. Administration will need to ensure spending is appropriate for goals and teachers may have to give up some professional development autonomy to support change. Technology support teams will have to work much closer with classroom teachers, and classroom teachers will have more autonomy in their technology use.

Changes in education do not come about easily, and changes which include technology are even more difficult because of enduring school cultures. Changing technology support models at time of reform should facilitate improvements to school's technological culture.

Implementation Considerations

In Fullan's (2010) whole-system reform model all parts of the system contribute to reform success, reform is aimed at improving student learning, reform has measurable effects, and all parts of the system participate in the reform. This framework seeks to fit into Fullan's model by ensuring proposed changes are measurable by stressing

learning advantages, digital divide issues, and new literacies and by ensuring participation by all parts of the system by including teacher training and improving technology support.

Often a gap exists between those making reform decisions and those implementing. The framework requires implementation to empower the teacher, be informed by theory and best practices and to respond to student needs. Schools and school structures will need to adjust in order for this to occur.

More to be done

The framework is not yet complete; it is a work in progress. Some areas still needing addressing are assessment practices, ways to measure efficiency and effectiveness, and economic feasibility. Authentic learning needs closer examination, as does impacts and implications of multiple digital divides. Reforms may appear in areas that are not technologically based. A model for implementation needs developing.

Conclusion

In conclusion, there are many groups espousing reform, many which have used or are using the term "21st century" to define their reform. Many of these groups are motivated by what they see as impending economic doom if educational systems do not adjust to a more technological society. As there appears to be no method to judge the merits of the proposed reforms, this paper outlined a framework for assessing a reform, based on improving students effectiveness and efficiency as learners, authenticity of the learning, support for teacher training and technology, and entrenching core literacy and numeracy skill and knowledge.

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