

DESIGNING FOR LEARNING IN THE 21ST CENTURY

Working Paper -- DRAFT

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When we look realistically at the world in which we are living today and become aware of what the actual problems of learning are, our conception of education changes radically. Although the educational system remains basically unchanged, we are no longer dealing primarily with the vertical transmission of the tried and true by the old, mature, and experienced teacher to the young, immature, inexperienced pupil. This was the system of education developed in a stable, slowly changing culture. In a world of rapid change, vertical transmission of knowledge alone no longer serves the purposes of education.

Margaret Mead (1958)

Introduction

Historically, the emphasis has been on teachers and schools as the source of information and education. By providing access to an ever wider range of social and informational resources, new technologies are expanding our notion of where “learning” happens across the physical-virtual map of a student’s life at the same time that they are setting up new challenges for how to integrate across these highly distributed experiences. The challenge is to design next-generation technologies that both enhance interest-driven learning experiences and advance complementary learning opportunities.

The purpose of this Working Paper is, first, to outline this vision of learning in the 21st century and, second, to present, based on that vision, a set of learning-driven criteria and design assertions by which next-generation environments might be considered. A theory of how learning transpires should allow us to design better technologies that lead to more transformative outcomes for the future rather than simply meet current standards of today. This Working Paper is still very much a work in progress and at this initial stage is merely intended to generate debate and discussion by articulating components and offering examples of learning in the 21st century.

DEFINING LEARNING IN THE 21ST CENTURY

Extensive research posits that learning is motivated by interest and executed as context-based processes mediated by social experiences and technological tools (Lave, 1990; Sawyer, 2006). This notion of learning departs from traditional cognitive paradigms, which pose that learning and knowledge is computed and stored in the minds of

individuals, much like a computer. Instead, it demands an understanding of learning that is about the acquisition of knowledge and skills through observing and collaborating with others, preferably in a heterogeneous peer group where novices can interact with experts.¹ Elaborating further the characteristics of learning in the 21st century, we argue that learning must be conceived as:

Self-directed

Learning is largely self-directed. Outcomes emerge through exploration and investigation. Becoming a successful self-directed learner leads to the dispositions and capacities for on-demand learning, complex problem-solving, and lifelong learning. While learning is intrinsically motivated, recognition for knowledge or artifacts produced can be generative.

Interest-driven

Learning can be motivated by personal avocation, professional vocation, social/political/cultural concern or cause, individual/identity development, or intellectual curiosity (Edelson and Joseph, 2004). Interest should not be confused with domain, theme, subject, or content matter. Rather, these more topically-oriented materials cross-cut interests and are mastered by the learner because doing so is the path toward advancing collective practice and achieving individual goals and aspirations.

Peer-based

Across these settings, youth can learn from “experts” at the same time that they teach, mentor, and coach less-experienced “peers.” In this cycle of learning and teaching, individuals acquire new and advance existing skills, understanding, talents through engagement in the informational resources and practical expertise of the group.

Practice-focused

Rather than looking to learning as only the acquisition of certain forms of skills and knowledge, learning is also about the integration of practice and the performance of real-world tasks that demonstrate their meaningful application. Distinct to this view of learning is that in addition to acquiring skills and knowledge as a result of participating in such communities, their particular cultural and social practices are also part of what is learned (Klopfer 2008).

Mastery-oriented

When a learner perceives that certain knowledge or skills are useful to the pursuit of or participation in an interest, he or she is drawn to master the knowledge or skills. Researchers have accumulated a considerable body of evidence showing the positive

¹ When individuals reach out to a set of relations based on their interests, what constitutes “peer” starts to change from age-determined to interest-based, enabling new models of positive adult-teen relationships.

impact of a mastery goal orientation on learning outcomes. We also know from research that the experience of having “mastered” skills in one arena creates a disposition of an expert and an understanding of knowledge structure that transfers to learning in other arenas (Rhoten et al, 2009).

The practices of interest-driven, socially-situated learning have long been part of the informal learning tradition, but typically distinguished from those of classroom teaching in formal education establishments. Increasingly, however, educators, policymakers, and families agree: schools cannot do it alone. Children and older youth need multiple opportunities to learn—at home, in school, and in the community. To meet the creativity and ingenuity levels of our students, there is a critical need to bridge nonformal learning by linking with classroom instruction through the use of technology and media. Researchers and designers are increasingly focusing on if and how digital media and technologies can be used to advance complementary learning as a systemic approach that intentionally integrates both school and nonschool activities to better ensure that all have the skills they need to succeed.

Intuitively and empirically, we all know that learning is not confined to formal settings. Indeed, a relatively small proportion of our lives is spent in formal education. Today, while the school retains the primary responsibility for core literacies and assessments, other goals of education – such as the development of civic identity or the development of the capacity for specialized learning – are increasingly migrating to more informal domains.

In some ways, this formal-informal divide has only been widened by digital media. While schools and libraries have adopted technology in a variety of ways, there is little doubt

INTEREST-DRIVEN LEARNING IN PRO-AM COMMUNITIES

Gaming, sports, and music are often considered the prototypes for the kinds of social and interest-driven learning in which youth have historically engaged. With the democratization of information and the distribution of resources, however, science, technology, politics, and arts are also proliferating as areas of “academic interest” around which new communities are coalescing. The evolution of astronomy is illustrative of this potential. Whereas astronomy used to be done in national “big science” research institutes, it is also done in global, interest-driven, Pro-Am open-source collaboratives. There is still a huge gulf between amateur astronomers and theoretical astrophysicists, but the line between professional and Pro-Am astronomers has become fundamentally blurred. Three factors have driven this transformation: (1) The innovation of high-powered, low-cost Dobsonian telescope that allow individuals to explore deep space on their own, (2) The emergence of CCD sensors, highly light-sensitive chips that can record very faint starlight more accurately than a photograph, enabled hundreds of thousands of new eyes to probe space and record data; and, (3) The Internet multiplied the power of this distributed capacity for exploration and education by enabling an amateur who has found something interesting to email the image to friends, colleagues, and professionals within minutes. By engaging in these practices toward the level of professional norms, amateurs and experts alike are developing and honing their scientific skills and knowledge by virtue of their personal avocation with potential implications for their professional vocation.

that in the U.S. at least the majority of young people's digital media use around learning happens in informal contexts centered on peer communication and personal interests (Buckingham 2007; Ito, et. al. forthcoming; Mahiri 2004). The Pew Internet and American Life Project illustrates how this disconnect has to date been aggravated rather than collapsed by the use of information technologies within and outside of schools. The Project surveyed a group of middle and high school students from different parts of the country to determine their use of the Internet. Virtually all of the students reported using the Internet to complete papers or similar assignments. But, they also identified roadblocks when they sought to use the Internet within classes and classrooms. The roadblocks included the uninspiring assignments and the absence of opportunities for creativity. Possibly, the study concludes, we are witnessing a widening gap between students who are "Internet-savvy" and their schools.²

But, an expanded formal-informal divide need not and should not be the only or the inevitable outcome of new information technologies and digital media. In fact, not only do information technologies and digital media have the potential to enrich interest-learning opportunities but, when conceived and configured correctly, they offer the bridge between informal and formal learning that has been missing to date.

DESIGNING LEARNING IN THE 21ST CENTURY

Fifteen years ago, Park and Hannafin (1993) noted that technological capacity and the intuition of designers tend to drive the design of multimedia rather than research and theory. Today, the success of next-generation environments to support socially-situated, interest-driven, and complementary learning require the rapid integration of research and design at all stages of the innovation process.

There is early evidence of this happening in the digital media and learning space. For example, prior to launching the new Web-based public service campaign on digital violence, the Family Violence Prevention Fund and R/GA (a digital advertising agency) researched the issue by setting up blogs and talking to teenagers. In so doing, the team first learned how youth use digital media and were then able to shape a campaign that not only reflects the way teenagers communicate but also respects the power of these peer-based communities to be the lever for learning. Additionally, by leveraging the power of Internet relationships with YouTube and Google, the campaign has also built in strategies for enabling and measuring impact and effect as the site evolves.³

Following from this logic, based on input from theory, research, and design, we offer a set of assertions by which environments might be filtered to enable and encourage 21st century learning as envisioned above. No product would have to encapsulate all these

² Sousan Arafeh, Doug Levin, Lee Rainie, and Amanda Lenhart, *The Digital Disconnect: The Widening Gap between Internet-Savvy Students and their Schools*. 2002. Pew Internet and American Life Project Web address: <http://www.perinternet.org>.

³ Clifford, Stephanie (2009). "Teaching Teenagers About Harassment," New York Times (26 January), http://www.nytimes.com/2009/01/27/business/media/27adco.html?_r=1.

assertions, but rather demonstrate some constellation of tools, products, and services with a clear set of explications about how the proposed configuration would advance socially situated, interest-driven, and technologically-mediated learning that leads to complementarity between in-school and out-of-school, physical and environment sites of practice.

For each assertion, there is a design criterion, a description of its meaning, and examples of the types of tools, products, or services currently in the market that incorporate or demonstrate the assertion in action at least in part (and not necessarily from the learning space).

1. *Affinity and Utility*

Criterion: Create and support environments that motivate learning and advance mastery of users as individuals and as a collective.

Assertion: To be effective, affinity spaces must be well-designed physical or virtual sites that are (or are part of) “learning systems” that resource and mentor learners (Gee, 2007). They should be built around shared practices and endeavors that invoke a social and individual “need to know.” As stated earlier, the intersection of affinity and utility can often be found in interest-driven arenas related to personal avocation, professional vocation, social/ political/cultural concern or cause, individual/identity development, or intellectual curiosity (Edelson and Joseph, 2004). Next-generation tools, products, and services that help individuals identify, assess, and move between affinity environments is essential to the future of learning systems that enable both interest-driven and complementary learning.

Examples: Affinity spaces can be constructed so as to encourage and resource learning in the sense we have explicated above (see for example, smARThistory.org, chessclub.com, fanfiction.net, or Project BudBurst). But these and other affinity spaces could be augmented with utility and extensibility applications that help individual users build out and move between affinity spaces in ways that help them achieve or accelerate their personal learning goals and bridge them across multiple environments. For example, with custom applications, students can turn their mobiles into a range of sophisticated tools could augment the extensibility and the utility of affinity sites in a variety of ways. Knowledge networking applications could also help users find, assess, and move more seamlessly between affinity spaces that meet their interests based on peer (including experts) opinions and evaluations. Such applications could also help users identify and organize activities across different affinity spaces that lead to articulated learning goals. While HotChalk is an early example of what could ultimately emerge in this space, it remains more of a learning and content management system primarily for teachers than a learning or knowledge networking application for students. Nevertheless, its success in the market speaks to the potential for future better-designed tools.

2. *Professionals and Amateurs*

Criterion: Encourage users from along the continuum of expertise (from amateur to professional) to engage in “peer” participation and production activities to the level of professional standards.

Assertions: The opportunity for users of different skills and expertise to collaborate around common tasks, problems, or challenges is essential. Enabling and exploiting environments to accommodate the participation and contribution of new as well as experienced, unskilled as well as highly skilled, and mildly interested to dedicated enthusiasts necessitates a variety of considerations. First, users must be able to assess their own interests, experience, and skills continuously as well as those of others in order to identify suitable peers for teaching, learning, and collaborating. Second, users should be able to observe the collective practice or endeavor from more than a single perspective, to enter it from more than a single point, and to participate in it in more than one way. Third, users should have access to expert thinking and mentoring as well as opportunity and responsibility for providing the same. Fourth, there should be pathways to promotion and users should be able to gain recognition for participation, contribution, and production as well as achieve status by moving along the pro-am continuum in different ways for doing different things.

While online communities have proliferated in many sectors, building a successful learning community continues to be one of those unresolved challenges in education. Arguably, this is because most online learning communities have been designed to replicate the roles and relations of the classroom rather than reflecting the social structures of interest-driven communities or peer production groups. Or, it is because they haven’t understood how to deploy the technologies and media in ways that both appeal to the user and also advance their learning.

Examples: The application Teach the People allows users to create interest-driven learning communities online via Facebook. At first glance Teach The People strongly resembles Facebook affinity groups, but offers a number of enhancements that make the platform more suitable for teaching and learning across peers of like interest but different expertise levels. Each member of the emerging Pro-Am group can upload documents, media, and online webcasts. Users can also make use of a Digg-like voting and rating system to review topics they’re interested in. Also important here and perhaps truer to the Pro-Am model is the Mozilla Foundation’s contemplation of how to better use Mozilla communities to promote learning through peer production and open source contribution. A more loosely structured and smaller scale Pro-Am example is Stories that Fly is a Pro-Am community news venture that features the very best narratives, photography and video from general aviation. The stories are contributed by student journalists, aviators, and interested community members and cover regional airports, events, and people in the Ohio aviation community.

3. *Content-Creation not Content-Delivery*

Criterion: Enable users to (co-)create and curate, articulate and evaluate knowledge and artifacts produced individually or collectively.

Assertions: Enabling the (co)-creation, curation, and presentation of artifacts leads to a variety of design considerations. First, individuals must be able to participate in building or modifying objects and contexts and/or contribute to knowledge production synchronously or asynchronously. Second, there must be spaces or interfaces where users can present and explain finished knowledge and artifacts to the collective or the broader public. Third, users must have access to multiple channels and criteria in order to comment on and contribute to the knowledge, experience, and artifacts as it is being generated at all stages of the process seamlessly.

Much of educational technology to date has focused on content delivery rather than on content generation. Such “e-learning” efforts have tended to focus on information or course management systems intended to reform education rather than on interactive and immersive environments designed to transform learning. Products like Blackboard have been successful from a business perspective, but they have had little direct impact on learning gains. Moreover, portals and repositories that simply aggregate and push academic information have not been successful products from either perspective (e.g., National Science Digital Library has an Internet traffic rank of only 95,523 whereas, just as a point of reference, Ask.com has a rank of 41, Wikipedia a rank of 8, and YouTube a rank of 3).⁴

Examples: Various online publishing and production tools can be employed in the learning process as a means for enabling collaborative practice and peer production at different scales and in different ways. Microblogging (Twitter, Facebook status updates) is a form optimized for social connections, but could be used to continue a conversation outside of classroom walls or provide an easy way to update students on course logistics. Tools for joint authoring around text, video, or sound offer extensive opportunities for peer-to-peer production of knowledge and artifacts whereby both the process and the output could also be highly educative. For example, currently in this space there is: Flat World Knowledge, which aims to provide free, peer-reviewed textbooks; WeBook, which is designed for the general public; or, Magcloud, which allows users to publish their own magazine. And, with the right applications, a simple laptop can be turned into an instrument, tutor, and recording studio all in one. Instrument simulators for piano, guitar, drums, and other instruments let students practice fingering and chords or compose simple pieces. Applications for ear training, reading music, and generating warm up exercises assist with basic practice. Applications can also let users can mix and record multiple tracks using loops, ambient sounds, or

⁴ These rankings come from Alexa.com, a database of information that includes statistics, related links, and rankings about Websites based on visits from users of its Alexa Toolbar. There are some questions over how representative Alexa's user base is of typical Internet user behavior.

voice recordings to create unique compositions. Through any of these tools, users can co-create physical or virtual artifacts and distribute them online or in the “real” world jointly or individually.

Collaborative game creation tools can be highly transformative in learning creative thinking as well as complex problem solving and systems thinking. As one example, in *LittleBigPlanet* (a community-based videogame for Playstation 3) players meet on a planet scattered with individual plots and use their character's abilities to play, create and share what they build with other gamers throughout the world. The *LittleBigPlanet* experience starts with players learning about their character's powers to interact physically with the environment. There are places to explore, creative resources to collect and puzzles to solve - all requiring a combination of brains and collaborative teamwork. As soon as players begin, their creative skills expand and they are soon ready to start creating and modifying their surroundings, which is the first step to participating with the whole community. Players can make their world as open or as secretive to explore as they like. When it's ready, they can invite anyone within the *LittleBigPlanet* community to come and explore— or can go and explore others'. Characters have the power to move anything in this 3D landscape; they have the power to design, shape and build both objects and entire locations for others to view and play. And, all of this is done in the context of a physics-based simulation, which implicitly and explicitly requires users to learn basic laws and principles. As sophisticated as this may sound, *LittleBigPlanet* is a commercially popular and accessible product. In fact, at \$50, it is cheaper than most software products. Other Web-based physics-based simulations for co-creation can be found in freeware online such as *Crayon Physics*.

4. *Distributed but Integrated*

Criterion: Help users to find new environments and transition seamlessly between them by introducing, scaffolding, and evaluating relevant academic, vocational or avocational interests and resources.

Assertions: Next-generation environments should enable people to acquire individual learning as well contribute to distributed learning. Distributed learning exists in other people, on sites, or in mediating devices to which other people in turn can connect or contribute their own individual knowledge. While new media are opening up a range of new options for users to access social and informational resources in a model of distributed learning, it has also set up new challenges about how to integrate and develop coherence across these highly dispersed experiences.

This points to the need for products, tools, and services that make it easy to develop and organize dynamic online content as well as tools that automate the process of contextualizing and connecting information across multiple contexts. Armed with tools for tagging, aggregating, updating, and keeping track of content, users cannot only navigate but create a Web that is increasingly tailored to their own needs and interests. In this regard, semantic-aware applications may offer future potential. Semantic-aware

applications are tools designed to use the meaning, or semantics, of information on the Internet to make connections and provide answers for users that would otherwise entail a great deal of time and effort.

Examples: End-user semantic-aware applications are, by and large, still in very early development. One early-stage application that illustrates some of the potential of semantic-aware applications, however, for interest-driven learning is Twine. Twine is a social network organized around topics of interest. Members join a “twine” on a particular topic, like biological evolution, where they can add resources and connect with others who are interested in the topic. Twine sorts resources into categories based on the type of information they contain: places, people, organizations, and so on.

Semantic-aware tools that help users visualize relationships among concepts and ideas are also just beginning to emerge, including mashups that not only plot data on graphs or maps, but also emphasize and illustrate conceptual links. For instance, WorldMapper produces maps that change visually based on the data they represent and could be used to teach multiple concepts difficult to grasp otherwise. Datascape is an even earlier stage interactive platform that allows users to overlay geographic space with place-based informational datasets or multimedia representations using mobile and web applications.

Section 7 will illustrate other relevant tools, products, and services that also connect to this criterion.

6. *Physical and Virtual*

Criterion: Link physical and virtual learning environments through activities and assessments that enable multiple pathways between them.

Assertions: A model of distributed learning does not mean abandoning schools or insisting that all forms of knowledge and participation are equal. Rather, a model of distributed or networked learning demands that we query the relationships between different forms and settings of learning, ranging from more youth-centered, interest-driven participatory forms to more formal and teacher-led forms. While it is important to appreciate the strengths of youth-centered and participatory learning, when isolated from other institutions and knowledge domains, these practices *may* not support the acquisition of a balanced set of content, skills, and dispositions necessary for full participation in adult civic and professional life. Thus, next-generation learning environments need to think not only about helping students make intellectual connections between interest-driven learning environments but also create institutional pathways between them and other sites of education. We know from empirical research that many youth who are highly engaged in creative, social, and intellectual agendas often turn to online networks to deepen their interests because of the diversity of resources, expertise, and knowledge they can access beyond their local institutional or geographic boundaries. However, we also know that many of these youth were rarely

able to link these interests back to the school or local institutions such as the library or museum (Ito et al. Forthcoming, 2008).

Examples: At one very obvious level, smart objects⁵ could offer a link between the virtual world of information and visualization with the “real” world of physical objects and temporal experiences. Smart objects can be used to digitally manage physical things, to track them throughout their lifespan, and to annotate them with descriptions, opinions, instructions, warranties, tutorials, photographs, connections to other objects, and any other kind of contextual information imaginable. Imagine a web search that reveals not pages of content, but the location, description, and context of actual things, place, and events from the “real” world.

Though smart objects have not yet entered the mainstream market, recent advances in identification technology have led to some interesting proof-of-concept applications that suggest everyday uses are not far off. For example, projects like Semapedia offer insight to some of the ways smart objects might benefit learning. Semapedia is a collaborative project that aims to connect tagged physical objects with online information from Wikipedia using QR codes. Users are invited to create cellphone-readable physical hyperlinks, print them out, and attach them to objects or locations in the real world. Semapedia includes a map indicating the corresponding physical location of objects that have been tagged. The Powerhouse Museum of Science and Design in Sydney, Australia has begun to utilize the Open Calais API to tag their collection. The museum's online collection database houses some 66,303 objects, so tagging them all by hand would be quite a task. But, by using the Open Calais web service, the museum is able to automate much of the process making them available to interested users.

A more systematic and integrated approach to complementary learning across physical and virtual demands a different set of sociotechnical tools and services that actually link and align face-to-face and digital-mediated learning environments. In this view of physical-virtual, one can envision the value-add of re-imagining “do it yourself” online sites, such as Instructables and Make for example, that are aligned with physical partners or offer companion courses in the “real” world at schools, libraries, and community colleges or places like TechShops and FabLabs. The possibility opens up multiple options for alternative pathways by which users could master avocational and vocational interests. Lighter weight geosocial awareness applications could also help users find places, groups, or events of interest near them. Currently in the pilot and planning phases is an organization call Extraordinaries. The Extraordinaries proposes to deliver short-term skills-based volunteer opportunities to people whenever and

⁵ A smart object “knows” about itself — where and how it was made, what it is for, who owns it and how they use it, what other objects in the world are like it — and about its environment. Smart objects can report on their exact location and current state (full or empty, new or depleted, recently used or not). Whatever the technology that embeds the capacity for attaching information to an object — and there are many — the result is a connection between a physical object and a rich store of contextual information.

wherever they are available by mobile phone. Designed like a game, the mechanics of The Extraordinaries (e.g., points, levels, and built-in competition), adoption and usage. The key difference is that by playing this game, the player does something useful for a nonprofit organization or public purpose such as: translating a nonprofit's Website into a foreign language; recording the GPS location of potholes and city infrastructure issues for municipalities, or identifying craters on the surface of Mars with NASA's Clickworker program. The inherent learning opportunities in this are unlimited; particularly if credits for performing could be translated to school records. Finally, in development is the concept of local games as learning experiences set in real-life neighborhoods and ecological habitats. Combining geolocation and alternate reality games, local games immerse the learner in a physical space as they explore the unique characteristics of the location and its inhabitants.

Section 7 will illustrate other relevant tools, products, and services that also connect to this criterion.

6. *Embedded and Authentic Assessment*

Criterion: Incorporate assessments of individual and collective performance and mastery through authentic methods and embedded mechanisms to automate data collection and advance analysis.

Assertions: As we begin to rely more and more on networked media that blend physical and digital interactions, new kinds of assessment methods and mechanisms become crucial if we are to develop a robust understanding of contemporary and complementary learning processes. Traditional methods of educational assessments, constrained to controlled and bounded learning settings are insufficient, as are traditional case-based ethnographic approaches to observing learning in situ. While survey based approaches can develop an overview of an individual's media use, quantitative measures don't lead to a grounded understanding of the actual content and processes through which youth develop learning identities, knowledge, and expertise over time. We need in-depth understanding of the qualities of engagement in specific contexts, as well as an understanding of how these engagements are distributed across different social, technical, and institutional networks and infrastructures.

One technology design strategy is embedded assessment, which is a method for measuring knowledge and ability as part of the learning activity rather than happening after the fact, through "soft sensors" or "virtual sensors." Soft sensors is a common name for software where several measurements are processed together, the interaction of which can be used for calculating or diagnosing complex behaviors. Soft sensors allow the collection of new data around learning that was previously unimaginable, which is of great interest and value to researchers and to teachers. However, such built-in assessment mechanisms combined with real-time user-facing feedback systems is of equal if not greater value to the learner as he or she progresses through a game or learns a practice. The value to the researcher/teacher and to the learner is augmented

that much further when there are tools to record and preserve a learner’s action history, more specifically a record of their competence development, which can be used to position themselves in relation to others in the immediate learning environment or in other environments to which they travel (physical or virtual).

Examples: There is some early development being done in game development where comprehensive backend databases are being built specifically to collect detailed data about what users create, the moves they make, the decisions they take, etc in that environment (e.g., Spore). There is also more intentional efforts to link these backend databases to broader learning systems across a platform and even between online and offline sites (e.g., Muzzylane). There are also important emerging work on intelligent agents and their role both in terms of their potential role for scaffolding affinity groups and assessing user behavior to enhance the learning potential of 21st century learning environments. Lastly, of course, is the work being done in the area of student portfolios and learning records.

RATIONALE AND EXPECTATIONS

Evidence suggests that individuals seem to learn more efficaciously and more equitably, without gaps between rich and poor, when they learn in informal areas they choose and for which they are motivated (Gee, 2003; 2004). Even three-year-olds can become experts on dinosaurs or trains, as Kevin Crowley has shown in his work on “islands of expertise” (Crowley & Jacobs, 2002). Nine-year olds can become Apple IIGS programmers and iPhone developers by following their interests and engaging with other senior programmers as Lim Ding Wen has demonstrated.⁶ We also know that 10-year olds are engaging the scientific method

THE POTENTIAL POWER OF 21st CENTURY LEARNING

In his work with low-income African American students engaged in playing *Civilization III*, both in a high school and an after school setting, Kurt Squire found that the participants, especially those reported to be among the lowest performing, “developed new vocabularies, better understandings of geography, and more robust concepts of world history” (2004).

Civilization III is a highly complex computer strategy game with its players succeeding by building empires—through a *recursive* process of trial and error—by way of managing resources, employing diplomatic and trading skills, and managing the advancement of culture and military power. Squire’s participants were identified by their teachers as underachieving in history classes or otherwise disinterested in historical subject matter, yet they were able to engage in a game which asked them to account for a host of interacting variables, including, among others, the implications of working within six types of civilizations, 6 government, and 13 geographical. Squire reports that engagement in this history-based game simulation, motivated some to ask questions like, “Why is it that Europeans colonized the Americas, and why did Africans and Asians not colonize America or Europe?”—questions, to be sure, that rarely surface in American history textbooks which tend to narrativize American and European history as the great westward expansion. This work points to how the design attributes of video games can support and accelerate learning.

Squire, Kurt (2004). *Replaying history: learning world history through playing Civilization III*. Unpublished Dissertation.

⁶ <http://www.reuters.com/article/technologyNews/idUSTRES140FI20090205>

through Spore and the concepts of physics through Little Big Planet and Fantastic Contraption.

Framing the problem about responsibility for learning rather than accountability for schooling forces us to think about how to support the acquisition of dispositions and habits, mindsets and skillsets, identities and abilities that enable learn in a range of contexts across a host of conditions over the course of time. The opportunities afforded by new technologies allow us to take out-of-school learning seriously, while the problems of traditional schooling demand it. While not a panacea, when intelligently designed and applied, technology and media can help schools and other responsible institutions promote the skills and literacies needed to succeed in the 21st century economy. And, by enabling more authentic, interest-based teaching and learning experiences, digital technologies and media can directly empower students with the talents and dispositions needed to succeed for full participation in a modern, democratic society.

Below are some categorical learning outcomes we expect this approach to defining and designing learning in the 21st century can advance:

- mastery of subject matter and complex language through interaction and application in a real-world context;
- processes of critical thinking and systems thinking, collective practice and complex problem solving;
- development of multistructural, relational, and extended abstract thinking;
- abilities to communicate and collaborate, evaluate and generate knowledge and artifacts;
- information, visual, and computational literacies (e.g., Photoshop is a virtual tutorial on the human visual system, and in combination with design work involves high-level literacies and technical skills); and,
- intellectual entrepreneurialism to design and engineer, transfer and execute learning on-demand and over a lifecourse, and;
- dispositions and identities to engage with a broader public and to contribute to the public good within community.

We are witnessing a moment when social learning theory is being revitalized by the growth of participatory and networked media and communication, but we are still at the early stages of developing a research field at this interdisciplinary nexus. In an age when more youth are dropping out of school at alarming rates, yet research is consistently showing the high levels of engagement youth are exhibiting in various media platforms, it is incumbent upon educators to take notice and indeed redirect teaching methods to meet the needs and interests of students.