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Learning, Knowing, and Reflecting: Literacies for the 21st Century

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The "aha" moments in life delight us. We suddenly gain an insight, experience a profound joy, or realize something important for the first time. A second grader provided for me a crucial "aha" moment about the purposes of education. As a regular part of their learning, students in this second grader's school throughout the year collected evidence of their learning in portfolios, pausing periodically to reflect on and explain the contents of the portfolio. On this particular day the second graders were sharing their portfolios with other students, parents, and guests, including me.

"I know you will want to know how I learn," began one student. "That's *very* important." With those few profound words this second grader taught me what we all need to realize: learning how we learn *is* important, in fact it is one of the most important things we can know and is what will sustain us in our rapidly changing world.

Understanding learning, turning information into knowledge, and developing the insight to reflect on learning, all elements of this second grader's portfolio production and presentation, are key abilities in the 21st century. Learning how we learn, how to turn information into knowledge, and how to document and reflect on life-wide learning are essential.

The second grader who became my teacher is growing up in a rapidly changing world. The 21st century features economic, social, and intellectual conditions that demand our attention. In an oft-cited 2005 book Thomas Friedmann declares that *The World is Flat*. He describes ten forces that have flattened the world, including the influence of computers in a widened market economy; digitalization; virtual offices; an intellectual commons movement with self-organizing collaborative communities; ecommerce; offshoring in which companies move whole companies from country to country; supply-chaining with horizontal collaboration among supplier, retailers, and customers; insourcing in which companies use large companies to provide sales and distribution; in-forming with personal supply chains for information and entertainment; and the kind of connectivity that is "incredibly fast and can be achieved anywhere at any time by any one." If we take seriously Friedmann's ten forces that have flattened the world, we probably should not even talk about "the 21st century." We should talk about a certain set of years or even a particular year because the circumstances of our individual and global lives are changing so rapidly.

Another source that emphasizes the changes in our world is the book *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies—and What It*

Means to Be Human by Joel Garreau. This book argues that four interrelated technologies--genetic, robotic, information, and nano processes--are "cranking up to modify human nature" (4). Garreau states that "we may be heading into a period when "we will start seeing creatures walk the Earth who are enhanced beyond recognition as traditional members of our species." Transmitting speech and pictures directly into the brain, building robots with living muscle, and producing machines that truly know what they are doing are all current projects in well-funded labs in multiple settings. In the near future, according to Gareau, many intelligences "will roam the earth that are not traditional humans."

In this same book Ray Kurzweil, a scientist and futurist, predicts that by 2020 people will communicate with computers called intelligent assistants as they do with human assistants through speech, gestures and facial expressions that the computers will recognize and respond to. Kurzweil says that by 2020 "Of all the total computing capacity of the human race—all human brains, plus the technology the species has created—10 percent will be nonhuman." But his more startling prediction is that by 2029 "Of the total computing power of the human race—all human brains plus all the technology that the species has created—more than *99 percent* will be nonhuman."

The circumstances of our world continue to change at a speed that makes us ask new questions about what education should be doing for and requiring of students. New ways of operating economically, socially, and intellectually necessarily shift focuses in education. In this fast-changing world we must educate students to know how to learn, how to turn the information that is now so accessible and ubiquitous into knowledge, and how to document and analyze their own learning.

First, it is important that students learn about their own learning. In fact, we can continue to listen to Garreau on this matter. According to his vision of the not-too-distant future, we will be able to buy all the long-term memory and reasoning we want, but it will not yet be possible to download knowledge directly. Garreau states that "Learning still requires time-consuming human experience and study. This is how humans spend most of their day. Automated agents also spend time creating knowledge. In fact, human and nonhuman intelligences are focused on the creation of knowledge. The largest profession is education."

In this scenario we human beings are still very central in the world even with the presence of automated agents. We are central because we can learn and can generate knowledge. In other words, knowing how human beings learn becomes even more central than it is today. Knowing how human beings learn in all realms of their existence is what keeps the human race going. Our doing the scholarship of teaching and learning, then, is foundational to our very existence.

Around the globe more and more faculty members in every discipline are focusing their intellectual work on how people learn in their disciplines. The International Society for the Scholarship of Teaching and Learning grows every year as faculty members expand their scholarly work to include designed inquiry into teaching and learning. The work of two mathematicians who study the way people learn mathematics serves as an illustration.

Professors Curt Bennett and Jacqueline Dewar are scholars of teaching and learning in mathematics. Bennett, a theoretical mathematician, developed a problem-based

learning course around semester-long, open-ended mathematical research projects intended to challenge students' assumptions about what it means to do math. To track the impact of this new approach, he administered surveys of student attitudes toward mathematics before and after taking the class, kept a journal, copied and analyzed graded homework assignments and exams, taped and analyzed office-hour conversations with student project groups, and conducted interviews with individual students after final grades. He found that in the problem based course students had a more mathematical view of the work of the field and what it takes to make a good mathematical problem. Equally important, Bennett asserts, it brought to light next questions about student learning, especially important in his field because mathematicians judge the value of a research question by what it leads to.

This example illustrates how important disciplinary basis is for this kind of scholarly work. Only expert mathematicians who are teaching and researching can ask appropriate questions, choose appropriate methods of inquiry, and make appropriate diagnosis and application of findings. In *Disciplinary Styles in the Scholarship of Teaching and Learning*, Mary Huber and Sherry Morreale demonstrate that scholarly work on teaching and learning is embedded in the epistemology of disciplines. Lee Shulman has written about the integrity of the discipline as an abiding theme in the work of many scholars of teaching and learning. He says, "If one is truly devoted to one's discipline, one is committed to transmitting and developing faithful conceptions and understandings of the discipline in students. Thus the integrity of the discipline leads to a sense of what is best for students."

If this is the case, however, we are still a long way from enacting the full concept of our disciplines. Although we socialize graduate students into the discipline, we often introduce undergraduates only to the content of a body of knowledge and not how that knowledge is formed, sometimes because we don't know enough ourselves about how novice learners come into disciplinary habits of mind and practices of our disciplines. Hence, of course, the scholarship of teaching and learning is essential work in all disciplines. Only those who understand and enact the discipline as their work can discover and develop those pedagogical understandings and strategies that will involve or engage new learners. If we leave our disciplines defined only as traditional subject matter, we are limiting their scope and power.

Yet, Professors Bennett and Dewar reached beyond their discipline as they needed new ways to answer emerging questions. In the next stage of their research, Bennett and Dewar studied how students grow in their view of mathematical reasoning and argumentation as the students move from beginning to advanced classes. They modified what is called a think-aloud methodology into what they call a proof-aloud protocol for probing students' thinking. They adapted a framework for assessing student learning overlaid with a model of student progression from novice to expert and reframed the whole for mathematical learning. The result is a mathematical knowledge expertise grid. Students are assessed developmentally as acclimated, competent, or proficient in factual, procedural, schematic, strategic, epistemic, and social competencies.

Bennett and Dewar are excellent models of scholars who know and care about their discipline and about *how* people do mathematics and become mathematicians. They have researched the *how* and have shared their knowledge with experts in their

discipline, like their faculty colleagues, and with novices in their discipline, like their students, to enable both groups to understand better how students learn.

Faculty members are not the only scholars about learning. An exciting development is the increasing amount and quality of student research in teaching and learning. At the 2006 International Society for the Scholarship of Teaching and Learning conference, faculty members from a Canadian university and two US universities explored how "undergraduate research about web portals can help transform learning by connecting scholarly communities, including students, faculty members, and professionals, and creating opportunities for sharing knowledge through public documentation, exchange, and peer review." Central to the discussion was how knowledge management and community of practice concepts contribute to expanding teaching and learning outcomes in undergraduate research programs. Students can be vital members of communities of researchers, learning about learning so that the knowledge base about how people learn in chemistry, philosophy, language, psychology, history, and all other disciplines is expanded and deepened. The content of most fields is changing so rapidly that people who know how to learn and how to continue to learn in their fields will be those who succeed in the workplace and even in their private lives.

A second kind of learning essential for students is information literacy, including turning information into knowledge. John Seely Brown and Paul Duguid in *The Social Life of Information* help us understand the distinctions between knowledge and information. First, "knowledge usually entails a knower." We may ask the question "Where is that information?" but we are more likely to ask the question "Who knows that?" Second, "knowledge appears harder to detach than information." Information can be quantified whereas knowledge is harder to count, to pick, or to transfer. Thirdly, "knowledge seems to require more by way of assimilation. It entails the knower's understanding and some degree of commitment." One might have conflicting information but not conflicting knowledge. "Knowledge's personal attributes suggest that the shift toward knowledge may represent a shift toward people. . . .including what they know, how they come to know it, and how they differ."

And this point returns us to those autonomous agents mentioned earlier, agents sometimes called chatterbots, which Brown and Dugid suggest "will play an increasingly critical role in the organization of social life." Although judgment and discretion are "products of human socialization and experience," because most humans can not understand the digital technology around which bots are built, it becomes difficult to know what and why bots make certain decisions. Brown and Duguid caution, "Once, as promised, bots start interacting with one another, understanding bot behavior may become impossible. If human agents are confused with digital ones, if human action is taken as mere information processing, and if the social complexities of negotiation, delegation, and representation are reduced to when x does y, bots will end up with autonomy without accountability. Their owners, by contrast, may have accountability without control." Brown and Duguid state that bots and humans operate in different, if overlapping, spheres. It is important to accentuate their complementarity. "But complementarity requires seeing the difference between information-processing agents and human agency."

Acknowledging the admonition to distinguish between information processing and human agency, students do indeed need to know how to find, evaluate, and use information. A helpful definition of information and communication technology literacy, used by the Educational Testing Service, is "the ability to use digital technology and communication tools to succeed in an information society. This includes the ability to use technology as a tool to research, organize, evaluate, and communicate information and the fundamental understanding of the ethical/legal issues surrounding the access and use of information." ETS suggests seven essential skills within information and communication technology, the abilities to define, access, manage, integrate, evaluate, create, and communicate. Importantly, the definitions of these terms link information to knowledge, knowledge that is associated, as Brown and Duguid remind us, with negotiation, delegation, and representation, those skills nourished in human communities. Businesses these days demand people who can work in teams because it is in social interaction that information can become knowledge. Because knowledge is socially constructed, our students must have practice in that construction and feedback about their applied knowledge as part of their preparation for this beginning of the 21st century.

A third aspect of learning that is crucial for students and for which we are responsible as colleges and universities is the ability to document and analyze life-wide learning. Research shows that students learn as much or more from out-of-classroom learning as they do in classrooms, so students must look across their lives for sources of learning. Indeed, students learn more deeply if they have practice in integrating learning from all aspects of their lives. For example, in electronic portfolios used as a learning tool in more and more educational settings, students can include a wide variety of evidence of learning in multiple sites in their lives: script notes from a community theater production in which they acted, a performance review from their job, a letter to the editor of a local newspaper, and photographs of a garden they designed using principles learned in math classes. When students demonstrate effects of learning or origins of learning across their lives, they demonstrate the integration that is a feature of deep learning.

In the Inter/National Coalition for Electronic Portfolio Research, currently over forty colleges and universities from five countries are studying how students learn through folio thinking. Folio thinking, a term coined by Helen Chen at Stanford University, means developing a habit of mind that builds connections across experiences and ideas and across learning experiences inside and outside formal schooling. Generating an electronic portfolio to represent that habit of mind demonstrates the thinking and learning for the portfolio maker and for the portfolio reader. To be specific, students collect on line artefacts, like essays; tests; videos of giving speeches, setting up biology lab experiments, working in a collaborative group, presenting a professional poster, or any other activity where action best represents the learning; journal entries, photographs, audio recordings of musical performances; or multiple versions of a revised report to show improvement over time. They select from those artefacts examples that demonstrate something about themselves as learners that they need for a particular purpose. For example, a student in a capstone course, the culminating course in a line of study, might include an essay from his first year of study on a split screen with a paper from his last year of study, reflecting on the differences in his writing abilities from the beginning to the end of his degree. Another student who may be applying for a job will choose those artefacts that the potential employer would see as pertinent to the student's ability

to do the job. For instance, if applying for a position as an engineer, a student might choose a diagram of a project rather than a philosophy essay, although the essay might be useful in another version of the portfolio designed to show interdisciplinary skills. The portfolio can be shared with a potential employer on-line before a face-to-face job interview.

In each case the student has reflected on his or her learning, thereby demonstrating ability to understand his or her learning in the rhetorical context of the occasion, in the first case of fulfilling a graduation requirement and in the second of securing a job. The electronic portfolio enables a rich array of ways to represent learning as well as a way to continue to represent learning over time. More and more colleges and universities are enabling students to maintain their electronic portfolios begun during their formal schooling after they leave their institutions. When students have developed folio thinking, they can continue on their own to use the portfolio for self understanding as well as for demonstrating to others what they know and can do.

Electronic portfolios, in fact, offer the distinct advantage of being both a learning tool and an assessment medium. As students select, present, and represent their learning, they reflect on what the portfolio artefacts reveal about their learning, reflection both generating and demonstrating insight. Assessors have the unusual advantage of seeing and reading both how students learn and the products of their learning, enabling a rich representation of learning in multiple media and over time.

Often we lament that tests are only snapshots of limited learning at a single point in time, whereas electronic portfolios offer a continuous account of life-wide learning with the potential for life-long representation as well. At various points the portfolio may be graded or rated for a certain purpose like completing a course, graduating from one academic level to the next, or ranking the student within a class. But, the real value is the practice of self-assessment that goes into a student's choice of artefacts, reflection on those artefacts, and demonstration of awareness of meeting learning goals or competencies. Students who practice folio thinking and eportfolio keeping are prime for the 21st century when they need to be flexible and adept at knowing when they need to change and when they need to know more. Assessment becomes part of the learning process.

Research on eportfolios reveals a range of learning benefits. For example, the Psychology Department at Clemson uses a Psychological Assessment Survey (PAS) that includes a range of competencies: disciplinary knowledge base, research methods, critical thinking skills, application, values in psychology, information and technology literacy, communication skills, sociocultural/international awareness, personal development, and career planning/development. In 2006 95 psychology majors enrolled in electronic portfolio lab courses completed the PAS at the beginning and at the end of the semester. Scores for discipline-specific competencies and for general competencies improved significantly over the semester (between 0.4 and 0.8 units on the 6-point Likert scale). Clemson researchers conclude that these results suggest that eportfolios can reveal student learning to both the student and to others. It is possible that both the reflection during eportfolio construction as well as the peer-evaluation during final eportfolio ratings sessions, harking back to the social construction of knowledge, contributed to these outcomes. The department researchers conclude that the combination of eportfolios and PAS tools may be a

valuable integration of learning pedagogy with classroom and program assessment strategies.

Another kind of research done by this Clemson team involved a focus on the structure of first-year and senior eportfolios using available website analysis software. To define a hierarchical score for these eportfolios, they assigned the entry page a score of 1. Any link from that page received a 2. Links from those pages received a 3 and so on. The hierarchical score for the portfolios was the average of all page values. The introductory lab portfolios were significantly lower in hierarchical value than the senior lab portfolios with means of 2.1 and 3.2 respectively. Several other objective measures differentiated the seniors' portfolios from the introductory portfolio, including a greater number of average lines (88 versus 50), external links (44 versus 17.5), and internal links (54.5 versus 40). The current results clearly suggest a greater integration and differentiation of artifacts in the senior sample compared to the introductory sample. Researchers note that these observations are encouraging since they suggest that the eportfolio structure may be a useful index of matured learning, communication, and self definition.

Notice that the research on the eportfolios at Clemson, while preliminary, helps researchers understand the rubrics that are appropriate for assessing developmental learning stages in psychology. Think how interesting it would be to engage students in this scholarly work. How would they account, for example, for the increasing integration of artefacts as shown by complexity of linking of artefacts? Could they do thinking aloud protocols on one another as they add artefacts to their portfolios? Would they be intrigued by how their uses of technology outside the classroom affect their abilities to use eportfolios to represent the evolution of their learning? We're back to the scholarship of teaching and learning demonstrated through this research on eportfolios, scholarship at Clemson related to how novice psychologists acquire and reveal the essential characteristics of their profession, and how technological structures are linked to complexity of reasoning in the discipline.

Whether a second grader or a novice psychologist, students are best prepared for the beginning of the 21st century when they know how they learn, when they convert information into knowledge, and when they document and reflect on their life-wide learning. The scholarship of teaching and learning contributes in significant ways to this learning, knowing, and reflecting.

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This presentation was given in longer form at a December 2006 international conference on the scholarship of teaching and learning at the University of Singapore.