Assistive Technology, Universal Design, and Gaming

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> "If the children are untaught, their ignorance and vices will in future life cost us much dearer in their consequences than it would have done in their correction by a good education." -- *Thomas Jefferson to Joseph C. Cabell, 1818.*

Public education for *all* citizens is rooted in early traditions of America society. Thomas Jefferson's commitment to education set the stage for great changes that occurred in American education over time. Each change brought increasing accessibility to education to an increasingly diverse population of learners. *Brown vs. Board of Education*, Public Law 94-142 and its Reauthorization in 1990, 1997 and 2004 each extended educational rights to more diverse student populations. With the entrance of a new millennium, a new opportunity emerged for Americans to embrace educational changes. The opportunity existed to merge new technologies with new educational practices, thus improving educational possibilities for *all* students.

LEARNING FOR ALL

Currently, legislation governing special education (IDEA 2004) mandates equal access to the general education curriculum for all special needs students. Yet, legislation can neither facilitate learning nor mandate success for all. The responsibility of learning and success rests with the highly-skilled, knowledgeable educators in our nation's schools. The new millennium brings advancements in technologies that influence the way people communicate, navigate, and educate. Through a variety of technologies, including assistive technologies and computer games, the future is rich with potential for supporting *all* students to reach their potentials. The challenge is creating and applying tools that assist educators in meeting the needs of increasingly diverse populations of learners.

Without legislation or sophisticated technologies, skilled educators intuitively understand and facilitate the convergence of individual learning needs and successful educational outcomes for *all* students. Yet, advancements in technology bring new insights from brain research to improve educational practices and help all educators meet new challenges. In presenting new understandings of brain functions and learning, David Rose and Anne Meyer (2003) note:

> "Historically, most ideas about individual learning differences have been based on the assumption that the brain is roughly the same all over and that its different parts are essentially indistinguishable with respect to their roles in learning…In contrast, most recent theories...are consistent with what we are now discovering about the learning brain – namely that students do not have a global learning capacity, but *many multifaceted learning capacities*, and that a disability or challenge in one area may be countered by extraordinary ability in another" (p. 6).

Skilled educators recognize and embrace these "multifaceted learning capacities" and incorporate them into their teaching practices. Through multiple teaching techniques, educators modify lessons, adapt materials, and allow for individual differences when assigning tasks and assessing student progress. Skilled educators embrace the challenge of special needs learners while others struggle with the diversity evident in modern-day classrooms. Struggling educators resist the changes forced by legislation and prefer to view students in predetermined categories of learners. Current research refutes these categories. According to Rose and Meyer (2002),

> "One of the clearest and most important revelations stemming from brain research is that there are no "regular" students. The notion of broad categories of learners – smart, not smart, disabled, not disabled, regular, not regular – is a gross oversimplification that does not reflect reality"(p.38).

Clearly, brain research and sophisticated medical technologies support the notions skilled educators apply intuitively on a daily basis in schools. But, technology offers more to diverse learners than PET scans, CT scans, MRI's or any combination of letters. Technology offers success for many students who struggle to learn via traditional methods and procedures. Technology offers help to skilled educators and those who struggle to meet the challenge diversity presents in education today.

ASSISTIVE TECHNOLOGY

The Individuals with Disabilities Education Act (2004) represents the third reauthorization of the original law that extended educational rights to special needs learners (PL 94-142). With reauthorization, IDEA 2004 expanded the definition and application of assistive technologies. According to IDEA 2004, assistive technology is "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain or improve the function capabilities of a child with a disability" (IDEA 2004, Federal Register, 2006, p. 217). The key concepts of "any item" and "used to increase, maintain or improve function capabilities" are important for educators and instructional designers. This broader definition opens opportunities to design, develop and implement a variety tools to help special needs students access curriculum and progress in less restrictive learning settings.

In educational settings, assistive technologies take many forms from low-technology (graphic organizers) to high-technology (voice recognition software). The overriding goal is to provide learners with the tools necessary to access the curriculum. In the simplest terms, assistive technologies are "the least complex options that effectively lower barriers to a student's educational achievement" (Castellani, 2005, p.23). Well-designed assistive technologies benefit *all* learners simultaneously and inconspicuously facilitate the success of special needs students.

In addition to recognizing the multifaceted nature of learners, skilled educators intuitively seek, recognize, and implement multifaceted ways of teaching. Skillfully taught lessons integrate low-tech and high-tech approaches to increase accessibility to all students. In addition, that integration appears seamless in nature. Absent of sophisticated terms, skilled educators flex methodologies to match the needs of learners. Without legislation, skilled educators deliver instruction in ways which open doors to learning. Unfortunately, the skilled educator's apparent seamless approach to teaching and learning is anything but seamless, requiring hours of careful, mindful, skillful planning and implementation. The question becomes how best to use all available advancements to make the apparently seamless, truly seamless.

TRANSLATION to TEACHING

Considering average classroom sizes, teaching to the multifaceted nature of individuals seems daunting. Recognizing that technological tools exist to support the process is helpful, but mastering the complexity of some technologies is equally daunting. Fortunately, there is much educators can do to become more skillful in the techniques skillful educators employ on a regular basis. Tools and techniques that apply the principles of Universal Design for Learning hold much promise for the future of education.

Universal Design for Learning (UDL) is a concept developed by the Center for Accessing Special Technologies (CAST). Based on principles of architectural design, UDL encompasses the notion that carefully designed instruction and materials enable all learners to access education on equal footing. Applied to emerging technologies such as video and computer games, UDL expands the vision of accessible instructional materials. Paired with the federal definition of assistive technology, UDL becomes a powerful means of meeting the needs of diverse learners.

UDL principles support a variety of educational practices including: differentiated instruction, learning as a process, cooperative learning, and multiple representations, presentations and demonstrations of learning. According to Rose and Meyers (2002),

> "The materials and methods teachers use can either present students with barriers to understanding or enhance their opportunities to learn. By developing and applying UDL, we can minimize barriers and realize the promise each student brings to school" (p. 8).

Related to advancements in brain research, UDL addresses three networks of functioning and learning: recognition, strategic and affective. Recognition networks process patterns received through the senses. Strategic networks enable individuals to plan, organize, execute, check, and evaluate skills and actions. Affective networks are influenced by internal emotions, reactions, needs and experiences (Rose and Meyers, 2002). This thinking lays the groundwork for blending growing knowledge of brain functions with new educational practices.

Applied to the classroom, recognition functions involve building factual information from prior knowledge, assimilating new knowledge with what is known. Strategic functioning supports instructional techniques that emphasize instruction followed by modeling, practice and feedback. Affective processing impacts how engaged, motivated, intimidated or overwhelmed a student may feel in approaching learning tasks. Consequently, supportive learning environments enable students to feel comfortable in taking the necessary risks of learning. Similarly, skillful instruction integrates prior learning with new information, scaffolds instruction allowing students to experience and build on success, and provides opportunities for practice and feedback. Suddenly, the daily practices of skilled, experienced, knowledgeable educators converge with modern advancements in brain research.

APPLIED to EMERGING TECHNOLOGIES

Advancements in technology extend deeper in today's classroom. Advances of the digital age make technology and new multimedia activities ubiquitous for young people. Options for information and entertainment seem limitless and far exceed those of previous generations. An endless variety of technological choices are fixtures in the lives of students, contributing to an increasing technologically savvy school population. High among the new activities is computer and video games.

GAMES AND THE MODERN STUDENT

Why are games one of the chief choices for the latest generation? Elizabeth S. Simpson (2005) answers with:

> "Kids today spend more time outside the classroom - exploring, questioning and problem solving - than they do "learning" in school. They make decisions based on their everyday experiences, their interests, their strengths and their desires. Their world expects them to interact with it and when they do so, they are in command. They welcome a challenge and the opportunity to test new boundaries. They are in control of their own destiny and the heroes of their own adventures" (p. 17).

Games provide an opportunity to meet these new challenges and desires. Through games young people make decisions, interact with an environment, accept challenge, and control their lives, if only in virtual worlds. A new line of thought by academic researchers capitalizes on a sometimes overlooked advantage of digital games, their powerful pedagogical capability.

When computers became part of the classroom landscape, digital games developed a role in learning. Historically, these games are simple programs often referred to as "Edutainment" and viewed as educational entertainment. Usually, these games serve drill-and-practice functions, similar to traditional worksheets. For example, a student responds to simple math problems on the computer screen. When a problem is answered correctly, the student is rewarded with a video, animation, or advancement of their on-screen counterpart. In reality, the game uses multimedia presentations to motivate students to perform academic tasks they otherwise could complete without technology. The game environment complements the completion of academic tasks and makes the tasks more palatable to students. This approach to using games in the classroom has benefits. Specifically, games incorporate affective brain functions and motivate students to complete academic work. Though work may transform into play via games, drill-and-practice games provide little higher order thinking, exploration, questioning and problem-solving. There is little added value to the overall learning process.

Modern games extend well beyond simple skill practice. Typical games, presented through a computer or a home entertainment system, such as Sony PlayStation 2 or Nintendo Wii, are intricate pieces of entertainment, and potential learning. Rich environments, dynamic challenges and complex interactivity capture the minds and attentions of young people and give purpose to their endeavors. Furthermore, these games leverage strong pedagogical principles that maximize learning and understanding in distinctly different ways than stereotypical classroom instruction.

GAMES and LEARNING

Games promote mastery of new knowledge and skills through a system of planned failure. Rarely are game-players expected to achieve consistent, immediate success when playing. In fact, when success is achieved too quickly, the game is deemed too easy and is met with distaste or lack of interest. Players expect to find a challenge that initially is beyond their skill set. Through game play, students gain necessary skills to overcome the challenge. Once the challenge is met, students repeat a cycle of learning as they apply their knowledge and develop new skills by facing new challenges. This process requires players to constantly analyze, synthesize, apply and blend new information with prior knowledge both inside and outside the game environment. Van Eck (2006) writes:

> "The extent to which games foil expectations … without exceeding the capacity of the player to succeed largely determines whether they are engaging. Interacting with a game requires a constant cycle of hypothesis formulation, testing, and revision. This process happens rapidly and often while the game is played, with immediate feedback. Games that are too easily solved will not be engaging, so good games constantly require input from the learner and provide feedback" (p. 20).

Most often early challenges are easily mastered, and later challenges require extensive thought and training. Frustration is avoided by making early challenges easier to complete. Players are constantly motivated to gain and practice new skills and knowledge to complete increasingly more difficult challenges. By nature, quality games are designed to scaffold learning.

In traditional didactic classroom settings, students listen to lectures with the usual expectations of note taking, memorization and regurgitation of information in the form of assessment. Games take a different approach in that students apply gained knowledge and skills immediately after acquisition. Players typically learn and practice skills or content through the mechanism of game-play and use their knowledge to overcome a challenge. The gaming environment provides the forum for practice. Shaffer, et al. (2005) write:

> "When knowledge is first and foremost a form of activity and experience -- of doing something in the world within a community of practice -- the facts and information eventually come for free. A large body of facts that resists out-of-context memorization and rote learning comes easily if learners are immersed in activities and experiences that use these facts for plans, goals, and purposes within a coherent domain of knowledge" (p. 8).

Any action or content in the game is relevant and consequently meaningful to the player. Thus, learning via game play becomes contextual.

The re-playability of games frequently produces different or altered environments. The result is increased opportunity for students to practice similar skills or knowledge in different contexts. In addition, students experience different effects of their knowledge or its multiple uses. Similarly, re-playability allows students to repeatedly explore a preferred environment or perform a favorite activity to develop mastery of content.

LOWERING BARRIERS to LEARNING

In several ways games hold potential for lowering barriers students may experience in education. The immersive nature of games creates highly motivating learning activities. The use of in-game counterparts, or avatars, encourages players to engage in learning and invest in the outcome. By controlling avatars, players become extensions of characters, or items. This enables students to depersonalize failure and take greater risks in learning. Edwin Ellis (1998) notes the importance of risk taking to the learning process. Ellis notes "because risk taking is a fundamental element of success, students should be taught to take responsible risks" (p. 11). Well designed games structure experiences and empower students to practice responsible risk taking within meaningful contexts.

Through multiple means and multiple chances, games also program for success. Often players are given several "lives" or allowed to save points and restart game play when a mistake is made. Some games have multiple and adjustable difficulty levels to allow players to experiment and match their level with their desired challenge. Jenkins (2005) writes:

> "In school, students often face considerable anxiety and sometimes harsh penalties if they make mistakes. In games, the best way to learn is to plunge in, make mistakes, lose your life, and then reboot so you can try again. Thus, games encourage exploration and experimentation" (p. 49-50).

Games are fundamentally efforts in interactivity. Players interact with an environment, under a set of rules, to achieve a goal. Many games provide multiple ways to achieve outcomes and gain success. Consequently, players stymied or frustrated with a particular skill or concept may apply alternative methods or information to accomplish the goal. The capability to use multiple paths to success allows for a wider range of learners and reduces players' stress in learning.

Some games are designed for multiple players, allowing either competitive or cooperative play; team-based learning is a proven effective method of instruction (Mainzer, Castellani, Lowry & Nunn, 2006). Games facilitate group play and reach learners through inclusive means of instruction. Even games designed for single player experiences frequently encourage and stimulate vigorous conversation and online communities where information and support are freely given. This is particularly advantageous for students who struggle to connect with peers in more traditional ways or more traditional learning environments.

To fully appreciate the engaging nature of games their narrative qualities must be examined. Modern games leverage powerful graphic capabilities of home computers or game consoles to produce precise, accurate and realistic qualities exponentially better than capabilities of the past. This, combined with sophisticated game design, results in virtual worlds which allow players to interact on levels only surpassed by reality. Players are motivated by immersion in a world designed for exploration, discovery and learning.

Returning to the principles of Universal Design for Learning, games and game play open new possibilities for increasing accessibility of learning and success.

> "Digital media also has the potential to transform the learning process… Instructional designers will use digital tools to tailor media to the task, to different kinds of learning, and to different kinds of students, reducing the barriers and inefficiencies inherent in one-size-fits-all" [approaches] (Rose & Meyers, 2002, p. 67).

Games represent a form of digital media that hold promise for lowering barriers and meeting the needs of *all* learners in today's diverse classrooms.

UNIVERSAL DESIGN and GAMING APPLIED

Games emulating the principles of Universal Design represent powerful tools of learning for diverse student populations. Through systematic failure, games activate prior knowledge found in the brain's recognition functions. Often failure in school evokes

negative feelings, yet failure in games builds toward ultimate success. Learning from and capitalizing on failed experiences are part of the gaming process. Likewise, learning from and building upon prior experiences are part of the educational process. In games, players build sets of knowledge as they accomplish goals, resulting in cumulative understanding and insight. An example of effective use of cumulative understanding is provided by the game, *The Sims*. In *The Sims*, players manage the lives of a virtual human. Initially, players are unable to meet the needs of their virtual humans immediately. Through exploration, experimentation and discovery, players gradually gain understanding of the game play and the virtual humans' communication systems. Through experience and pattern recognition, players amass knowledge allowing them to make more accurate interpretations within the game. Correct interpretations increase knowledge and understanding of the basic needs of a virtual human. Players apply prior knowledge in a cycle of learning to achieve success.

Similarly, well designed games support the brain's strategic functioning via modeling, practice, and feedback. Games consisting of initial tutorials, practice sessions, and evaluations or scores are particularly supportive of strategic functions. In *Civilization IV*, players guide a civilization, such as the Romans, from their foundation to the present and beyond. In theory, learning curve is steep for a game that attempts to build an entire civilization. The content is vast and factors to control are complex. To compensate for the steep learning curve, *Civilization IV* presents new players with a virtual version of the game's main designer. The virtual designer guides players step-by-step through the initial phase of the game. Additionally, the designer offers explanations for accomplishing certain goals and advice for maximizing success in the game. Feedback is provided regularly by comparing the players' civilizations to others on a variety of measures. Throughout the game, players may access virtual advisors for suggestions and advice individualized to players' unique styles of play. The result is a game that models effective methodology and opportunities to practice skills based on individualized feedback and commentary.

Almost all games possess motivating aspects that support affective processing. Primarily, most games are concerned with keeping players engaged and motivated through a balance of challenge just short of frustration. Strong narratives engage players emotionally, increasing investment in the game's outcome. Early frustrations are avoided by scaffolding challenges and gradually increasing difficulty. Players are encouraged to immediately apply skills or knowledge gained, avoiding a sense of overwhelm when asked to apply large amounts of knowledge at once. The math game *Dimenxian* exemplifies this principle. In the game, players control an onscreen avatar to save a computer system from virus infestation. Players must use a combination of standard game-play and math to correct the system. As players begin the game a story explains the situation and why they, the players, are necessary and important. Initially, players are

given relatively easy tasks. Gaming and math skills are learned and immediately required to progress. If players experience difficulty, the game offers clues or advice for ways to progress. Future versions of the game will offer re-playability through tasks that vary certain content to allow further practice of math skills. In contrast to more common drill-and-practice computer games, *Dimenxian* manages to integrate complex brain functions with game play.

The aforementioned games illustrate the potential application of Universal Design for Learning principles to modern instructional practices. Accessibility to games for some special needs students is increased further through specialized assistive technologies. Adaptive equipment increases access for students who struggle with a variety of visual, auditory or motor impairments. Games hold great potential for increasing access to knowledge, learning and understanding.

CONCLUSION

> "I do hope that in the present spirit of extending to the great mass of mankind the blessings of instruction, I see a prospect of great advancement in the happiness of the human race…" *--Thomas Jefferson to Cornelius Camden Blatchly, 1822. ME 15:400*

Potentially games, like skillful instruction, integrate prior learning with new information, scaffold instruction allowing students to experience and build on success, and provide opportunities for practice and feedback. Like skillful instruction and masterful educators, games invite students into the world of learning and provide an engaging environment for exploration and discovery. As instruction is part of an overall process for fostering academic success, so games are part of reaching students with diverse learning needs. Games designed according to UDL principles represent a panacea for some students challenged by traditional tasks in traditional learning environments. Similarly, games offer solutions for educators responsible for meeting the challenges of teaching diverse populations of learners. Through the lens of Universal Design for Learning, games broaden the opportunity for *all* students to participate in the process of 21st century education, side-by-side, shoulder-to-shoulder, barriers removed. The future of education holds the hope that talented instructional game designers will partner with the talented instructional designers found in our nation's schools – those skilled, knowledgeable, masterful educators. The combined talent will produce boundless results in an effort to seamlessly blend the worlds of games, teaching and learning. Work will become play, and Jefferson's dreams of education for *all* and "happiness of the human race" will be realized.

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