WHITE PAPER

Does the Use of Technology Improve Learning? The Answer Lies in Design

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As an Associate Professor of Instructional Design and Technology, I'm often asked if certain technologies enhance learning or to compare the relative effectiveness of two or more technologies. Do [educational] video games increase student achievement and/or motivation? Is Web-based distance education better than conventional face-to-face (f2f) classroom instruction? How about virtual worlds and mobile devices? While I understand the interest in such questions, particularly from administrators who may be responsible for making high-cost purchasing decisions, I argue that asking whether a particular technology is effective or if one technology is better than another for promoting learning is no longer meaningful. Decades of media comparison studies have shown that the technology used to deliver instruction has relatively little to no direct effect on student learning or motivation. To be more precise, the design of the instruction accounts for more variance in how and why people learn than the technology used to deliver the instruction. As such, I encourage educators and educational researchers to focus on determining how to better integrate the use of a given technology to facilitate learning, rather than asking if it works or if one is more effective than another.

Educators and educational researchers have considered the effects of mediated instruction for over a hundred years. In 1910, George Kliene published the first catalog of instructional films for public schools and in 1913, Thomas Edison predicted that books would soon become obsolete because, "It is possible to teach every branch of human knowledge with the motion picture." In 1920's, The National Academy of Visual Instruction was formed and Dorris published one of the first textbooks on visual instruction, advocating the use of 'seeing experiences' such as pictures, models, exhibits, charts, maps and graphs to enrich education. In the 1930's and 40's, the radio received considerable attention (e.g., Woelfel & Tyler, 1945) and advances in sound and audio recording technology shifted focus from visual to audiovisual instruction. In 1947, the Department of Visual Instruction (DVI) becomes the Department of Audiovisual Instruction (DAVI) and McGraw Hill Book Company manufactured its first textfilms, designed to supplement textbooks by expanding the visual treatment of the subject matter. The 1950's saw the growth of television and a number of studies compared televisions versus traditional classrooms as a means for delivering

education. In 1952, Alabama established the first statewide educational television network, and in 1956, one the largest single experiments on the use of closed-circuit instructional television was conducted in Hagertown, Maryland. Inspired by Hagertown's early success, the Ford Foundation then began a nationwide study on the use of Interactive Television that included over 200,000 students in over 800 elementary and secondary schools.

Although early studies on the use of instructional media did yield some interesting results (e.g., younger students are more effectively taught by television than are their older peers; simplified line drawings may be more effective than high quality photographs), for the most part, researchers found that: (a) learning can take place through the use of audio, still images, or motion pictures as well as one-way or two-way, interactive educational television as the sole means of transmitting information; and (b) when compared with "traditional" classroom techniques, audio recordings, still images, motion pictures and (either one or two-way) educational television programs of the same content produce no significant differences in learning.

With the advent of the personal computer, computer-based tutorials, simulations and simple drill and practice games became popular in the 1970's and 80's. Like earlier forms of instructional media, computer-based instruction (CBI) and computer-based training (CBT) were compared to traditional, face-to-face (f2f) classroom instruction. For example, Jamison, Suppes and Wells (1974) conducted a comprehensive review of media comparison research and found no significant differences in achievement were typically reported between the use of computers, televisions and radios compared to traditional classroom instruction. While some studies reported advantages for media, others reported greater achievement with traditional instruction. They concluded, "When highly stringent controls are imposed on a study, the nature of the controls tends to force the methods of presentation into such similar formats that one can only expect 'no significant differences' which were found" (p. 38).

Concentrating on studies comparing CBI and CBT to traditional classroom instruction, Kulik and Kulik (1991, 1987) and Roblyer (1989) used meta-analytic techniques to synthesize and analyze findings and to better estimate effect size. Although significant differences in final exam scores were found in several cases, closer examination revealed that most of the large effect sizes attributed to the use of computers were actually due to poorly designed studies and other confounding factors (Clark, 1983). For instance, when studies involving only one teacher in the planning and delivery of the instruction were considered, the positive effect of media tended to disappear. "The evidence in these meta-analyses….is that it is the method of instruction rather than the choice of medium that leads directly and powerfully to learning" (Clark & Sugrue, 1994, p. 353). Such findings led Clark (1983) to coin the popular phrase that, "[…] media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (p. 445).

Reviews of research examining the relative effectiveness of educational video games have lead to similar conclusions. For example, O'Neil, Wainess, and Baker (2005) located over 4,000 articles about computer games published in peer-reviewed journals and found only 19

studies that included qualitative or quantitative data about learning or motivation. In addition, their analysis of the learning and transfer measures used in all 19 studies concluded, "… positive findings regarding the educational benefits of games…can be attributed to instructional design and not to games per se. Also…many studies claiming positive outcomes appear to be making unsupported claims for the media." (p. 461-462). Similarly, in her dissertation research, Kebritchi (2008) noted that the majority of research reviews on the effectiveness of computer games yielded either mixed results (Hays, 2005; Mitchell & Savill-Smith, 2004; Randel, Morris, Wetzel, & Whitehill, 1992) or found no positive effects (Emes, 1997; Harris, 2001). As with other forms of technology, in some cases, the use of games resulted in slightly higher levels of achievement and/or motivation compared to traditional classroom instruction while in other cases they did not. In addition, Kebritichi, Hirumi and Bai (2010) found that what teachers did before and after game play was as important, if not more so, to learning than the game itself, further substantiating the importance of design.

As Internet access has become more pervasive, an increasing number of organizations are offering web-based training and distance education programs. Many, in turn, have questioned the relative effectiveness of on-line programs to traditional classroom instruction. In one of the most extensive efforts to synthesize such research, Bernard, Abrami, Lou, and Borokhovski (2004) analyzed 688 studies comparing classroom and distance learning offerings of the same course and found no differences in either learning or motivation. Focusing primarily on adults in business and college settings, Sitzmann, Kraiger, Stewart, and Wisher (2006) reviewed 96 studies and found the same result. Apparently, web and classroom-based instruction yield similar amounts of learning and are equally motivating.

While research indicates otherwise, Seels (2011) suggests that practice provides considerable evidence that technology does influence learning by: (a) addressing students' and teachers' media preferences; (b) interfacing content and learners; (c) creating a context for communications; (d) offering alternative ways to produce, store, present, and distribute information; (e) enhancing motivation, attention, perception and retention; and (f) providing models, symbolic representations, interactivity, cueing, and vicarious experiences. Obviously, different technologies offer different capabilities. It would be difficult for teachers to interact with students from all over the world with a stand-alone computer and no Internet access. Although media may simply be vehicles for delivering instruction, you wouldn't want to transport sushi in a van with no refrigeration. But, the capabilities investigated so far (e.g., motion, sound, simulation, connectivity) are not exclusive to specific technologies. Each capability may be provided by other technologies and no capability has been found to produce unique cognitive effects (Clark & Sugrue, 1991).

So, how will the use of virtual, mixed and augmented realities compare to web-based and traditional classroom instruction? Can social networking sites, such as Facebook, Second Life and Bebo enhance learning? What about the advances in mobile technology and the continued development of Web 2.0 technologies? With the advent of new and emerging technology, a fresh crop of studies will inevitably appear either demonstrating the

instructional effectiveness of the technology or comparing the new with an older technology. Each new technology seems to attract its own set of advocates who ask research questions that seem similar to past media studies and claim their technology improves learning and/or motivation. However, as I've argued throughout this paper, it's how the technology is used and integrated with instruction that makes the difference, not the technology used to deliver or others facilitate the instruction.

For many of us, the classroom was pretty much the same as when our parents went to school. The teacher stood in front, acting as the epistemological center of authority, and lectured to the groups of students who were expected to start and complete the same curriculum at the same pace and at the same time. Parents and other members of the community contributed to our learning, but typically, in an uncoordinated manner (as depicted on the left side of Figure 1). Even with the infusion of personal computer in the 1970's, 80's and 90's, schools and more importantly, the educational experience remained predominately teacher-centered until the late 1990's and early 2000's when the Internet and high speed networks became more prevalent. The World Wide Web gave students direct access to the knowledge base and enabled teachers to become learning facilitators, helping students to access, interpret, organize, synthesize and apply information, rather than directing students to memorize and regurgitate information for an upcoming test. Advances in information technology also facilitated communications among students and between family and community members as well as experts around the world, further breaking down the barriers of traditional classroom walls and promoting the development of student-centered learning environments (as depicted on the right side of Figure 1).

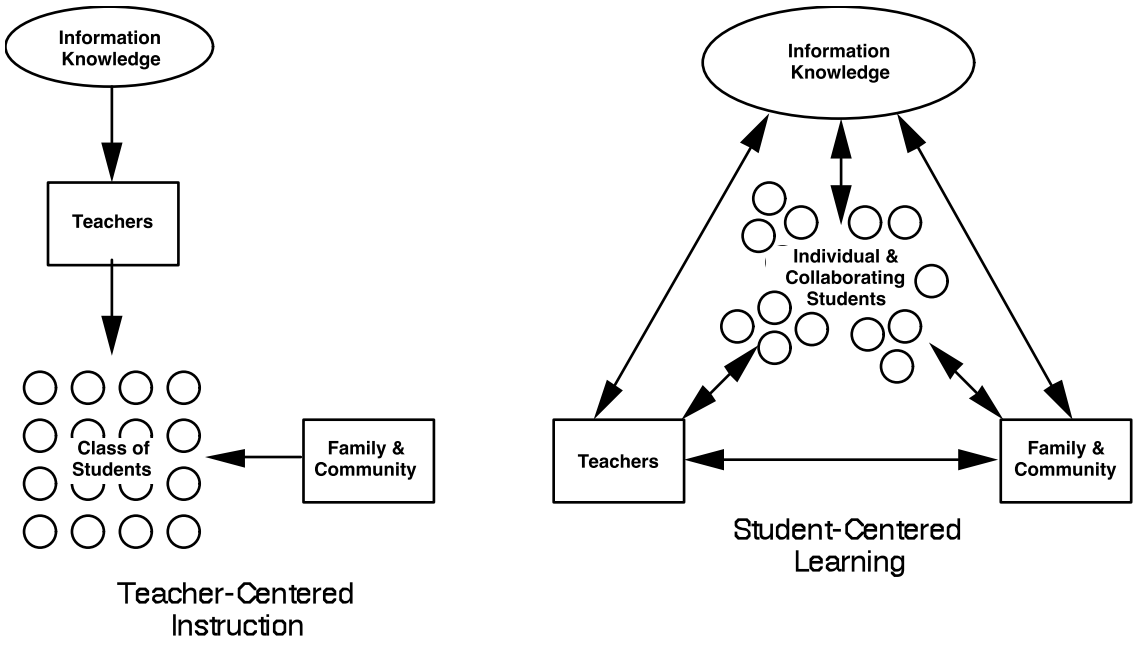

Figure 1. A comparison of teacher centered and student centered learning environments (from Hirumi, 497-537.)

Now, Web 2.0 technologies, such as YouTube, wikis, and blogs, allow students to readily create and share user-generated content, providing tools to further the concept of student-centered learning. However, rather than questioning if Web 2.0 or other emerging technologies promote learning or if one technology is better than another, we should investigate how to best integrate these tools to facilitate student learning and motivation. Current research and literature provide some initial insights. For instance, Shelly, Gunter and Gunter (2010) suggest challenging students to establish community-based blogs to discuss issues important to local government or to communicate with and assist senior citizens. Other recommendations include, but are not limited to tasking students to produce and share short digital video clips using YouTube to demonstrate their knowledge of a topic, and having students create wikis to build communication and teamwork skills (Shelly, Gunter & Gunter, 2010). In my opinion, questioning what educators can do before, during and after the use of technology, and testing alternative strategies to facilitate learning are the keys to improvement.

Over the past 100 years, literally thousands of studies have shown benefits from the use of technology, while others report higher achievement with classroom instruction, and even more result in "no significant difference." I, like others, believe that such mixed results reveal that the design of instruction makes the difference in learning, not the medium used to deliver the instruction. The question is no longer if technology enhances learning, but rather how do we improve our use of technology to enhance learning? So, the next time you're

asked if mixed, mobile, game, audio, video, virtual, distance learning, social media, Web, Web 2.0 or other emerging technologies enhance learning, or if one is better than another, you can say, "the answer lies in design."

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