Multimedia use in higher education: promises and pitfalls

Gregory Krippel
Coastal Carolina University

A. James McKee
Fort Lewis College

Janette Moody
The Citadel

Abstract

The typical undergraduate student of today is accustomed to receiving information on a daily basis in a variety of formats, i.e. multimedia channels. This can present a challenge to educators wishing to engage students in the classroom while still providing required content in order to enhance learning outcomes. Although technological tools purporting to aid in the delivery of educational content are expanding at an ever-increasing rate, supporting research of their effectiveness has been limited and scattered. In order to assist educators in choosing from the myriad of multimedia options available, this paper provides an overview of what constitutes educational "multimedia" and presents research evaluations of their effectiveness. These research findings consider not only the educational content being delivered, but also variables associated with the receivers, i.e., the student audience. The paper concludes with suggestions for new research areas that consider variables and environments not previously studied.

Key words: Multimedia, pedagogy, technology, literature review, higher education

Introduction

Educators continually search for more effective ways to engage their students during learning as well as to increase student learning outcomes. Various technologies have been touted as being able to provide the ultimate delivery mechanism to achieve these laudable goals. However, while the technologies purporting to provide solutions are changing at an exponential pace, the true effect of these technologies on learning outcomes remains unclear. The multitude of student (individual) variables plus the myriad of content and situational variables interact with the delivery mechanisms in such as way as to confound the applicability of many of the research results.

This paper provides an updated overview of research on the use of multimedia for educational purposes in order to highlight under-researched areas, and offers suggestions for future research projects that will help clarify the appropriate use of multimedia by educators. The paper begins with a review of what educators and researchers consider multimedia and its importance to the learning process. It then provides a representative though not exhaustive review of research findings to date, and concludes with areas of additional research to guide educators wishing to utilize multimedia tools.

Background

Humans receive data through multiple channels, i.e. media, including audio and visual channels (Paivio, 1969) as well as touch, taste and smell. Multimedia is most commonly defined as the use of at least two of these elements: sound (audio), and text, still graphics, and motion graphics (visual) (Tannenbaum, 1998). To date, the majority of the educational research projects do not include the other media of touch, taste and smell. The importance of multiple channels for delivery of educational content can be found in the theory of multi-channel communication which confirms that when information is presented by more than one channel, there will be addition reinforcement, resulting in greater retention and improved learning (Ellis, 2004; Bagui, 1998; Daniels, 1994).

Furthermore, although not stipulated by most researchers assessing the effectiveness of instructional multimedia, Tannenbaum (1998) posits that multimedia must include an interactive component. This interactive component must allow the learner to interact with the material in such a way as to control the outcome of the presentation, thereby necessitating that it be under the control of a computer (Tannenbaum, 1998). In fact, Drave (2000) suggests that the quality of interactivity is more important than content for the success in learning. (Evans & Gibbons, 2007, 1148). The importance of the interactive component is supported by the constructivist learning theory that says that an enhanced degree of control results in deeper learning outcomes (Smock, 1981; Zimmerman, 1981 by Ellis 2004).

Thus, although some educators may define the use of PowerPoint as a form of multimedia (Butler and Mautz, 1996), few utilize its interactive components, and therefore it fails to meet Tannebaum's (1998) definition of a "strong" form of multimedia. Instead it would appear to constitute a "weaker" form of multimedia based on its use of text, sound, and animation. However, there has been extensive research into the use of PowerPoint as a multimedia learning tool, and therefore in keeping with this paper's purpose, some of that research is included.

Synthesis of Multimedia Research

The promise of revolutionizing education through the use of multimedia can be found as early as 1922 when Thomas Edison proclaimed that "the Motion picture is destined to revolutionize our educational system and that in a few years it will supplant…the use of textbooks" (cited in Cuban, 1986, 9 by Mayer, 2005, 8). Other proclamations include Benjamin Darrow who proclaimed that radio would "bring the world to the classroom" to make universally available the finest teachers. His colleague, William Levenson predicted in 1945 that a "radio receiver will be as common in the classroom as the blackboard" and " radio instruction will be integrated into school life" (cited in Cuban, 1986, p 19 by Mayer, 2005, 8). Consider also the history of educational television combining visual and audio; by the 1950s educational television was touted as a way to create a "continental classroom" that would provide access to "richer education at less cost" (Cuban, 1986, 33 by Mayer 2005, 8)

Fifty years later the game-like computer-assisted instruction (CAI) programs that were touted as the wave of the future in education proved to be no more effective than teacher based modes of instruction (Cognition and Technology Group at Vanderbilt, 1996). Schrand (2008) notes that when technology enabling distance learning first appeared claims were being made that it would replace face-to-face instruction and that digital technology would lead to education customized to the needs of learners (Taylor and Schmidtlein, 2000). For example they noted that in a 1998 report Coopers and Lybrand suggested that distance learning and other digital innovations were going to transform education (Ibid). Yet Schrand (2008) notes that 20 years later, despite the dramatic predictions, our universities still retain their familiar appearances and that the dynamics of student learning in the typical university classroom remain largely pre-revolutionary (Ibid).

Perhaps one of the reasons for the lack of a massive overhaul of the traditional educational delivery system it that research on the learning outcomes of using multimedia has resulted in contradictory findings (Bryant and Hunton, 2000). These seemingly conflicting results may be due to the soundness of the research methodologies, as well as the confounding effects of the novelty variable (Bryant and Hunton, 2000). In addition, the research studies have been formulated on multiple theoretical bases.

Examples of these theoretical bases include constructionist learning theory, individual learning styles theory, and various cognitive architectures (Reed, 2006). In addition, studies have examined a variety of factors such as the context of the material being taught. Constructionist learning theory states that giving the student more control over the pace of learning and the navigation within the lesson should lead to greater and deeper learning. (Smock, C. D. 1981; Zimmerman G. J., 1981, Ellis 2004 and Mayer 2005) However, the navigation control combined with unguided or minimally guided instruction seems most often to harm learning for low-prior-knowledge of the subject matter. Thus multimedia's facilitation of the constructionist-based discovery and problem-based learning pedagogy failed to produce favorable learning results. On the other hand, strong instructional guidance and scaffolding seems to interfere with the learning of more advanced students. Scaffolding is the pedagogical technique of providing more tracing and cognitive mastery support for novice students, then withdrawing it slowly as they gain expertise. (100)

The theoretical foundations of individual learning styles have also influenced instructional design (Mayer and Massa, 2003). Research indicates that spatial learners (Burke and James, 2008) and those with low prior knowledge (Ollerenshaw, Aidman, and Kidd, 1997)

outperformed high-prior-knowledge students and were most benefited by use of multimedia. Other beneficiaries of multimedia include surface learners who are learners that are externally motivated who will implement strategies to avoid working too hard or failing. For surface learners, it is suggested that standard multimedia can be effective but instructors are urged to add interactivity to challenge knowledgeable achievers or deep learners. However, multimedia is not beneficial to deep learning of internally motivated, knowledgeable achievers (Ibid).

Multimedia has been found to be highly beneficial to visual learners but detrimental to highly verbal individuals (Butler and Mautz, 1996). On the other hand, adding animated pedagogical agents does not seem to increase learning and may diminish instructional effectiveness, because agents often produce cognitive overload for students.

Personality types also provide clues as to when the use of multimedia will be effective. Ott, Mann and Moores (1990) hypothesized that the Introvert, Intuitive, Feeling, Judging personality types would prefer multimedia training, while the Extrovert, Sensing, Thinking, Perceiving would prefer lectures. However, after thirty years of testing multimedia instruction that accommodates different learning styles, there is still no convincing evidence that multimedia instruction designed to accommodate learning styles results in learning improvements.

As noted earlier, PowerPoint is considered a "weak" form of multimedia, and is well-known for its over-use in both the classroom and the boardroom. Craig & Amernic (2006) studied whether or not the use of PowerPoint led to more effective learning (149). They cite Tufte, (2003a) who argues that PowerPoint elevates form over content (147); Nunberg (1999 p. 330) who states that PowerPoint is denounced by academics and CEOs for causing determental effects on "dialogue, interaction, and thoughtful consideration of ideas" and Goldkorn (2004) who accuses PowerPoint of "replacing clear thought with unnecessary animations, serious ideas with ten-word bullet points, substance with tacky, confusing style." Craig & Amernic (2006, 148) further argue that despite PowerPoint's wide spread adoption, the relatively few authoritative studies of its effectiveness is surprising. Generally they find the available studies lack substance, internal and external validity, and operationalized a limited concept of effectiveness. The studies generally partition students into two groups: one receiving lectures with overheads, and the other receiving PowerPoint presentations. Craig & Amernic (2006, 150) observe that there is scant consistent evidence, however, to show that teaching with PowerPoint leads to significantly better learning and significantly better grades than teaching by more conventional methods. In fact they argue that a majority of studies (Rankin and Hoaas ,2001; Bartsch and Cobern, 2003, p. 78; Stoloff, 1995; Susskind & Gurien, 1999, Szabo & Hastings, 2000 Exp. 1 and 3; West 1997; Bartlett, Cheng, & Strough, 2000) show that use of PowerPoint is not associated with a significant improvement in student grades. One study that demonstrated a decrease in student performance when the instructor switched to PowerPoint (Bartlett, Cheng, & Strough, 2000)(Ibid 150). Craig & Amernic (2006, 150) did note some studies that suggested PowerPoint presentations lead to improved recall (ChanLin, 1998, 2000; Lowry, 1999; Szabo & Hastings, 2000, Exp. 2). After a review of these studies, Craig & Amernic (2006, 156) conclude that PowerPoint's effectiveness is contingent upon the discipline, the learning objectives, and learner types. They recommend that faculty study new technology first rather than accepting them blithely and unquestiongly (157

Conclusion and Suggestions for Future Research

This paper has provided a brief overview of the status of research in and application of multimedia as an instructional device. The review provides us with the conclusion that pedagogy must drive educational technology usage, rather than the reverse. The first stage of a new technology is always accompanied by unrealistic expectations of its revolutionary advantages and universal applicability. This stage is followed by the indiscriminate application to any number of educational areas. Not surprisingly, the results are disappointing and inconclusive with some studies indicating improvement while other studies suggest either no improvement over conventional pedagogies or even evidence of these new technologies being less effective then conventional pedagogies. Not only does the confusion arise because often the multimedia technologies used were not based on proven multimedia design principles, but also because of questionable research methodologies used in the studies. For example, the novelty factor is often a confounding, but unadjusted for, variable. Novelty alone substantially influences the amount and depth of information processing and recall (Restorff, 1933, cited by Craig and Amernic, 2006). Lynch and Scrull (1982) confirmed Restorff's (1933) findings that "almost any technique that served to increase the novelty of particular items or led them to be unexpected enhanced the recall of those items (Ibid, 280).

Thus the problem is not with the new technology but rather with the unrealistic "great expectations" of "universal" applicability to all areas of the educational environment. What is needed is an examination of the educational environments where the new technologies yield superior results. Even more important is an examination of those environments where the new technologies either show no improvement or under performed versus conventional pedagogies. Research must be designed to identify and define the characteristics of the educational environments in which studies have shown the new technology to be effective as well as the educational environments in which evidence has shown it to be ineffective.

The next task is to use the knowledge of the educational environmental characteristics favorable for applying the new technology and identify them in specific disciplines. Studies have shown that for abstract conceptual and theoretical content material multimedia will be effective (Butler & Mautz, 1996; Burke, James and Ahmadi, 2009, 249). On the other hand, for quantitative areas in which the material requires extensive problem solving, the use of multimedia may not be effective (Butler & Mautz, 1996). An evaluation of the appropriateness for multimedia technologies for a specific discipline would include such factors as the nature of the discipline's content knowledge to include its degree of "analyzability" and its "task complexity".

Low analyzability as gauged by the degree of the task content that can be interpreted or represented in rules, is an important indicator of task uncertainty has been called analyzability (Sun & Cheng, 2007). Low analyzability indicates that fewer rules are needed for interpretation or representation, resulting in more uncertainty. Therefore, the lower the analyzability of the discipline's content, the more multimedia will be effective and efficient. For example, many tasks in accounting and finance courses can be characterized as highly analyzable because of the high number of rules for interpretation. This content area would be considered highly analyzable and multimedia would be less likely to be effective and efficient in the learning process
High Task complexity: the more complex the task, the greater the quantity of information needed and thus the more multimedia will be effective and efficient. (Sun and Cheng, 2007). In addition, multimedia would seem to be indicated to support tasks that are abstract and conceptual

(Butler and Mautz, 1996; Burke, James, and Ahmadi, 2009, 249). For example, some higher level accounting tasks can be considered very complex and conceptually abstract, and thus for these areas of accounting content, multimedia will be effective and efficient. On the other hand, for quantitative material requiring problem solving, the use of multimedia may not be effective (Butler and Mautz, 1996). In these situations, the use of a step-by-step instruction that allows students to see problems worked out in real time would be considered more effective than multimedia presentations (Burke, James and Ahmadi, 2009).

Based on this review of past research into the efficacy of multimedia instruction and the diversity of outcomes, there would appear to be ample opportunities for future researchers to make significant contributions to the field. The overriding conclusion would be that pedagogy must drive educational technology usage rather than the reverse. New technology is always accompanied by unrealistic expectations of its revolutionary advantages and universal applicability. This is followed by indiscriminate application to any number of educational areas. Next may come disappointing and dismal mixed results with some studies indicating improvement but also a similar number of studies suggesting either no improvement over conventional pedagogies or even evidence of these new technologies being less effective then conventional pedagogies. The problem is not with the new technology but with unrealistic "great expectations" of "universal" applicability to all areas of the educational environment. Confounding this problem is that often the multimedia presentations were not designed using sound multimedia design principles.

Therefore, what is needed is research that examines the educational environments in which the new technologies yield superior results and even more importantly to examine those environments where the new technologies either show no improvement or underperformance over conventional pedagogies. Such research can identify and define the characteristics of the educational environments in which the new technology has evidence suggesting that it is effective as well as to identify and define characteristics of the educational environments in which the new technology has evidence suggesting that it is ineffective. Based on this evidence, educators can utilize multimedia technologies effectively and efficiently.

REFERENCES

Bagui, S. 1998. Reasons for increased learning using multimedia. Journal of Educational Multimedia and Hypermedia, Vol 7, No. 1. 3-18.

Bartlett, R. M., S. Cheng, & J. Strough. 2000. Multimedia versus traditional course instruction in undergraduate introductory psychology. Poster presentation. Annual Conference of the American Psychological Association, Washington, DC.

Bartsch. R. A., & K. M. Cobern. 2003. Effectiveness of PowerPoint presentations in lectures. Computers and Education, 41, 77-86.

Beets, S. Douglas, and Patricia G. Lobinger. 2001. Pedagogical Techniques: Student Performance and Preferences. Journal of Education for Business. 76. 231-235.

Bryant, Stehanie M. and James Hunton. 2000. The use of technology in the delivery of instruction: Implications for accounting educators and education researchers. Issues in Accounting Education. Vol. 15, No. 1129-162

Burke Lisa A. and Karen E. James. 2008. PowerPoint-Based lectures in business education of student-perceived novelty and effectiveness. Business Communication Quarterly, Vo. 71. No 3 277-296.

Butler, J. B. & R. D. Mautz Jr. 1996. Multimedia presentations and learning: A laboratory experiment. Issues in Accounting Education. 259-280.

ChanLin, L. J. 1998. Animation to teach students of different knowledge levels. Journal of Instructional Psychologh. Vol 25. 166-175.

Cognition and Technology Group at Vanderbilt. 1996. Looking at technology in context: A framework for understanding technology and education research,. In D.C. Berliner & R.C. Calfee (Eds.). New York. Macmillan. Handbook of educational psychology.

Craig, Russel J. and Joel H. Amernic. 2006. PowerPoint presentation technology and the dynamics of teaching. Innovation in Higher Education. Vol. 31 147:160.

Daniels, L. 1999. Introducing technology I the classroom; PowerPoint as a first step. Journal of Computing in Higher Education, 10, 42-56.

Drave W. 2000. Teaching online. River Falls, Wisconsin: LERN books

Ellis, Timothy. 2004. Animating to build higher cognitive understanding: A model for studying multimedia effectiveness in education. Journal of Engineering Education. January 2004.

Evan, Chris and Nicola J. Gibbons, 2007. The interactive effect in multimedia learning, Computers & Education. 49 1147-1160

Lowery, R. B. 1999. Electronic presentation of lectures—Effect upon student performance. University Chemistry Education. 3, 18-21.

Lynch, J. G., & T. K. Srull. 1982. Memory and attentional factors in consumer choice: Concepts and research methods. Journal of Consuver Research, 9, 18-37.

Mayer, Richard E. 2005. The Cambridge handbook of multimedia learning. New York. Cambridge University Press 1-635

Mayer, Richard E. 2008. Applying the science of learning evidence-based principles for the design of multimedia instruction. American Psychologist. 760-769

Mayer, Richard E. and Massa, L.J. 2003. Three facets of visual and verbal learners: Cognitive ability, cognitive style, and learning preferences. Journal of Educational Psychology, 95, 833-846.

Ott, R. L., M.H. Mann, and C.T. Moores .1990. An empirical investigation into the interactive effects of student personality traits and method of instruction (lecture or CAI) on student performance in elementary accounting. Journal of Accounting Education, 8. 17-35.

Paivio, A. 1969. Mental imagery in association learning and memory. Psychological Review, Vol. 76, 241-263.

Rankin, E.L., & D. J. Hoaas. 2001. The use of PowerPoint and student performance. Atlantic Economic Journal, 29. 113.

Reed, Stephen K. 2006. Cognitive architectures for multimedia learning. Educational Psychologist, 41(2), 87-98.

Schrand, Tom. 2008. Tapping into active learning and multiple intelligences with interactive multimedia. College Teaching. 78-84.

Smock, C. D. 1981. Constructivism and educational practices In I.E. Sigel, D.M. Brodzinski & R.M. Golinkoff (Eds.), New Directions in Paigetian Theory and Practice. . Hillsdale, NJ: NJ: Erlbaum. 51-68.

Stoloff, M. 1995. Teaching physiological psychology in a multimedia classroom. Teaching Psychology. 22. 138-141

Sun, Pei-Chen and Hsing Kenny Cheng 2007, The design of instructional multimedia in e-Learning: A Media Richness Theory-based approach, Computers & Education 49, 662-676.

Susskind, J., & R. A. Gurien. 1999. Do computer-generated presentations influence psychology students' learning and motivation to succeed? Poster session, annual convention of the American Psychological Society, Denver.

Szabo, A. & N. Hastings. 2000. Using ITin the undergraduate classroom. Should we replace the blackboard with PowerPoint? Computers and Education, 35. 175-187.

Taylor, A.L. and F. A. Schmidtlein. 2000. Creating a cost framework for instructional technology. Technology Source November/ December 2000. http://technologysource.org/article/creating_a_cost_framework_for_instructional_technology.

Tannenbaum, Robert S. 1998. Theoretical foundations of multimedia. New York: Computer Science Press

Tufte, E. R. 2003. PowerPoint is Evil. Wired. Retrieved on December 8, 2004 from http://www.wired.com/wired/archive/11.09/pp2.html

Tufte, E. 2005. PowerPoint does rocket science-and better techniques for reports. Retrieved December 6, 2006, from http://wwwedwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001yB&topic_id=1.

West, R. L. 1997. Multimedia presentations in large classes: A field experiment. Paper presented at the Annual Convention of the American Psychological Society, Washington DC.

Zimmerman, B.J. 1981. Social learning theory and cognitive constructivism. In I.E. Sigel, D.M. Brodzinski & R.M. Golinkoff (Eds.), New Directions in Paigetian Theory and Practice. . Hillsdale, NJ: NJ: Erlbaum. 39-49