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STRATEGIC APPROACHES TO INSTRUCTIONAL MULTIMEDIA DESIGN

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This paper explores the nature of learning, the various types of approaches to facilitate learning, and the importance of technology within the learning process. This paper focus on generative theory of multimedia, self-efficacy, and self-determination theory that have been applied to various multimedia learning processes.

Keywords: Learning, Technology, Multimedia, Self-efficacy, Self-determination.

Introduction

Research in the area of multimedia learning so far has focused on the effectiveness of instructional methods and course design. Various approaches of delivery have been investigated and basic principles in terms of memory and associated cognitive process identified (e.g., Fletcher & Tobias, 2005; Low & Sweller, 2005; Mayer, 2005). Examining pedagogical strategies which encourage students' conceptual understanding of the way the world works is very important. (e.g., Efendioglu & Yelken, 2010; Trey & Khan, 2008).

Roots of Instructional Design

Instructional design has its roots in the work of Skinner and Gagne. Skinner represents the epitome of the behaviorist tradition in psychology. He argued for a formal systematic design of instructional environments based firmly on the principles of behavioral learning theory. Gagne however, realized that learning theory was not sufficiently developed to meet the wide ranging demands of instructional design. In his seminal book *The Condition of Learning*, first published in 1965, he produced a formal systematic framework of types of learning. There was clearly a gap between what learning theory at the time could offer and what instructional designers needed. Gagne extrapolated beyond the evidence and produced a formal framework to guide teaching practice. This 'creative leap' made by Gagne provided the basis for the subsequent development of instructional design. In the view of its critics it also provides its central weakness. Laurillard's central criticism of Instructional System Design (ISD) is that it '… has only a tenuous link to any empirical base' (p.72).

Instructional design has developed a clear method with a strong element of prescriptive guidance. In this method there are three main stages in instructional development – needs analysis, selection of instructional methods and materials, and evaluation.

The aim of the needs analysis stage is to precisely analyze the nature of the task. This analysis is meant to identify every sub-task the student must do and every piece of knowledge the student must

acquire. The underlying assumption is that the systematic analysis of task requirements will map onto the steps the learner will have to go through to acquire the knowledge. This analysis will normally yield a hierarchical classification where goals are broken down into sub-goals, and the content required to achieve the lowest sub-goals is specified. Based on this task analysis the objectives of the teaching program can be specified. These objectives are stated in terms of measurable outcomes. At the end of the analysis stage it ought to be possible to specify a series of tests which will indicate whether or not each learning objective has been met.

When the objectives of the instruction have been fully specified the designer then chooses the instructional methods and resources required to achieve these objectives.

Table 1. The Nine Instructional Events.

External instructional events	*Internal learning process*
1. Gaining attention	1 Alertness
2. Informing learner of lesson objective	2 Expectancy
3. Stimulating recall of prior learning	3 Retrieval to working memory
4. Presenting stimuli with distinctive features	4 Selective perception
5. Guiding learning	5 Semantic encoding
6. Eliciting performance	6 Retrieval and responding
7. Providing informative feedback	7 Reinforcement
8. Assessing performance	8 Cueing retrieval
9. Enhancing retention and learning transfer	9 Generalizing

(Source: Price, 1991)

The prescription of instructional theory are used to guide this process. Price (1991) states "In order to ensure that each learning process happens, the CAI author should include a sequence of nine instructional events that 'teach' for each objective" (p.84). These nine instructional events are based on the theories developed by Gagne and his colleagues (e.g., Gagne and Briggs 1979). The nine teaching events are set out in Table 1. These events represent a sequence of steps that should normally be followed from 1 to 9. Price, however, comments that the selection of event order should be tempered with common sense.

The development of the instructional framework is expected to be iterative. Prototypes are developed and assessed through formative assessment. The feedback from the formative evaluation is used to tune the prototypes until the required level of performance is achieved. At the end of the development period the instructional program should be tested on a larger sample of the target audience (Price, 1991). Satisfactory performance on this summative evaluation means that the program can be released for general use. This instructional design strategy is largely media independent. It could be used to guide the development of a computer based system or a text based open learning program.

Theories and Applications to Instruction Multimedia Design

Many achievement motivation theories have been developed in psychological research to explain people's choice of achievement tasks, persistence on those tasks, and resulting performance (Wigfield & Eccles, 2000).

Generative Theory of Instructional Multimedia

In his Generative Theory of Multimedia Learning, Mayer defines multimedia as the presentation of a material by supporting it with a picture or a text or, in other words, in more than one form. According to this theory, multimedia, as a noun, refer to the technology by which a material is presented visually and verbally. The term, as an adjective is a word which refers to learning through words and pictures;

multimedia message\presentation refers to a presentation which includes words and pictures; and multimedia instructional message\presentation refers to a presentation which includes words and pictures with a view to ensure learning (Mayer, 2001).

Mayer makes use of three cognitive theories when structuring his theory: Dual Coding, Limited Capacity, and Active Processing.

Table 2. The cognitive Theories Underlying the Generative Theory of Multimedia Learning.

Name of the Theory	Definition	Developers of the Theory
Dual Coding Theory	Human beings use two different channels to process visual and auditory information.	Paivio, 1986; Baddeley, 1992.
Limited Capacity Theory	Human beings are able to process limited information in each channel simultaneously.	Baddeley, 1992; Chandler & Sweller, 1991
Active Processing Theory	Human beings are active learners who perceive external information, and select relevant data and organize them into meaningful information with their prior knowledge.	Wittrock, 1989; Mayer, 1999

(Source: Mayer, 2001)

Mayer (2001), whose theory on the design of effective multimedia learning environments is based on Dual Coding. Limited Capacity and Active Processing theories, define individuals who enter into a process of learning as active learners who use two channels to process visual and auditory information, process limited information in each channel simultaneously, perceive external information, and select relevant data and organize them into meaningful information, and integrate this information with their prior knowledge. Mayer distinguishes between auditory\verbal and visual\pictorial channels used by learners to process information. Mayer (2001) mentions that, in a presentation, verbal or nonverbal auditory elements (e.g., narration (uttered words), background music, etc.) are processed in the auditory\verbal channel and verbal or nonverbal visual elements (e.g., animation, written text, etc.) are processed in the visual\pictorial channel; and these channels process limited amount of data in one go.

Kolb introduces the abovementioned learning styles, assuring that individuals differentiate in organizing and perceiving information. Accordingly, accommodators make use of Concrete Experience in perceiving and Active Experimentation in organizing. They like new experiences and planned working. They prefer acting on the basis of their feelings rather than mental analyses and acquiring information through dialogues with people rather than technical analyses. The most outstanding strengths of the people having this learning style are practically, leadership and courage to take risks (Kolb, 1993).

Divergers make use of Concrete Experiences in perceiving and Reflective Observation in organizing. Individuals having this learning style are able to see concrete situations from different perspectives. Their approach to events is limited to observing rather than taking action. They enjoy producing various ideas on an ample scope through methods such as brainstorming. They have vast cultural knowledge and like collecting information. Among the remarkable strengths of divergers are creativity, understanding others, being aware of problems and developing a large perspective about an event by brainstorming (Kolb, 1993).

Assimilators make use of Abstract Conceptualization in perceiving and Reflective Observation in organizing. Individuals having this learning style are able to comprehend and transform comprehensive information in a large interval into a meaningful whole. They prefer dealing with abstract concepts and topics rather than tacking people. They generally attach more importance to logical validity of theories than their practical value. They are good at planning, creating models, defining problems and developing theories. It will be useful to develop their skills through exercises on organizing information, creating

conceptual models, testing theories and ideas, designing experiments and carrying out quantitative data analysis (Kolb, 1993).

Role of Self-Efficacy in Instructional Multimedia

While the traditional expectancy-value models have focused on outcome expectancies, Bandura (1977, 1993, and 1997) has argued that efficacy expectations should also be considered as they are more predictive of performance and choice than outcome expectations. Self-efficacy and outcome expectations do not have the same meaning. Outcome expectations involve beliefs about the anticipated outcomes of those actions. For instance, a student may believe that a positive outcome will result from certain actions but also believe that they lack the competence to produce those actions. The concept of self-efficacy, developed from social learning theory, refers to perceptions of one's capabilities to engage in courses of action that will lead to desired outcomes (Bandura, 1977, 1993, 1997). There are two important features in Bandura's construct of self-efficacy operates within a specific context (e.g., incorporating internet resources to prepare a PowerPoint presentation on global warming). The second element of the construct refers to judgments of the behavior one is capable of performing independently of the value one attached to the given actions. For example, an individual may have a high self-efficacy for doing a presentation but draws little self-worth if the task is perceived to lack value.

Research shows that self-efficacy can influence behavior in achievement settings (Bandura, 1993; Pajares, 1996, 1997; Schunk, 1989, 1991). Students with low efficacy for learning may avoid attempting tasks; those with high efficacy would participate more eagerly by expending greater effort and persist longer in the face of difficulties. In a study estimating the unique contribution of self-efficacy to work-related performance controlling for personality, general ability, and job or task experience, Judge, Jackson, Shaw, Scott and Rich (2007) found that self-efficacy predicted performance in low complexity task but not in medium or high complexity tasks. Based on Bandura's (1986) guidelines of assessing self-efficacy for specific tasks, scales for computer self-efficacy were developed and validated (e.g., Murphy, Coover, & Owen, 1989; Zweig & Webster, 2004). In their study of students undertaking a teaching qualification, they look at the motivational factors involved in a compulsory computer skills course that consists of face-to-face instruction and self-paced web-based learning. They found a moderate correlation between self-efficacy and test results (Jin & Low, 2007).

Role of Self-Determination Theory in Instructional Multimedia

According to self-determination theory (Deci & Ryan, 1985), one of two types of motivation, extrinsic or intrinsic, gives rise to an action. Intrinsic motivation refers to doing something because it is inherently interesting, and extrinsic motivation refers to doing something because it leads to a separable outcome (usually some kind of reward). Intrinsic motivation is viewed as an innate human need for competences and self-determination (Deci & Ryan, 1985; Deci, Vallerand, Pelletier & Ryan, 1991) and is therefore influenced by environmental and interpersonal variables that affect experiences of competence and self-determination (Reeve, Nix, & Hamm, 2003). In self-determination theory, motivation is conceptualized as a continuum with intrinsic motivation at one end and extrinsic motivation at the other. In between are behaviors that were extrinsically motivated initially but have become internalized. More recently, Ryan and Deci (2000) have added another construct, amotivation, to the theory. Amotivation refers to the state of having no intention to act and it resides next to extrinsic motivation.

Intuitively, intrinsic motivation is an important construct in educational contexts. Consider the situation where students enrolled in a compulsory multimedia computer skills course may want to avoid some difficult web-based activities but work on them to avoid failure (e.g., the students are extrinsically motivated). As they become more competent, they perceive a sense of control and self-determination over the multimedia learning (i.e., they become intrinsically motivated). The activities become more

intrinsically motivating and positive social factors (feedback) assist the learning process. However, as some researchers (e.g., Pintrich & Schunk, 2002; Reeve, Nix, & Hamm, 2003) have pointed out, relatively little attention has been paid to educational implications of self-determination theory. Ryan and Deci (2000) have suggested that the basis for maintaining intrinsic motivation and becoming more self-determined lies in the social contextual conditions that support feelings of competence, autonomy, and relatedness. Therefore, in learning contexts, it is important to create instructional conditions that satisfy the innate needs to feel connected and effective as one acquires knowledge and skills. Recently researchers (e.g., Deimann & Keller, 2006; Kuhl, 2000) have reintroduced and validated a relevant construct "volition" (originally raised by James, 1902) to educational research. According to Deimann & Keller (2006), volition (or willpower) is "one's capability of maintaining attention and effort toward goals in spite of possible distractions due to waning motivation or competing goals" (p.139). they point out that, since multimedia learning design and processes are likely to encounter problems such as learner's uncertainty, distractions, "seductive" details, and cognitive overload, research and teaching programs in the direction of volition enhancement are much needed.

Role of Multimedia

The emphasis of multimedia design and development has been on the presentation of information in multiple formats (Hede & Hede, 2002). There are a number of overlapping definitions of multimedia. According to Doolittle, "web-based multimedia represents the presentation of instruction that involves more than one delivery media, presentation mode, and/or sensory modality" (2001, p.3). Multimedia has also been defined as "the use of multiple forms of media presentation" (Schwartz & Beichner, 1999, p. 8) and "text along with at least one of the following: audio or sophisticated sound, music, video, photographs, 3-D graphics, animation, or high-resolution graphics" (Maddux, Johnson, & Willis, 2001, p. 253). Although numerous definitions exist to capture the essence and meaning of multimedia, "one commonality among all multi-media definitions involves the investigation of more than one media" (Jonassen, 2002, p.207).

Examples of multimedia include, but are not limited to, text in combination with graphics, audio, music, video, and/or animation. The theoretical value of multimedia inclusion is supported by a range of basic learning principles. The cognitive theory of multimedia learning is based on the following:

1. Constructivist learning theory in which meaningful learning occurs when a learner selects relevant information, organizes the information, and makes connections between corresponding representations;
2. Cognitive load theory in which each working memory store has limited capacity;
3. And dual coding theory emphasizing that humans have separate systems for representing verbal and non-vernal information (Moreno & Mayer, 2000).

In supporting this inclusion of multimedia, the multimedia principle finds that "students learn better from words and pictures than from words alone" (Doolittle, 2001, p.3). Hede and Hede (2002) find that games and simulations afford goal-based challenges that trigger interest and increase user motivation, and they also suggest that providing tools for annotation and collation of notes promotes learner engagement. Moreno and Mayer (2000) provide additional information to suggest "active learning occurs when a learner engages in three cognitive process – selecting relevant words for verbal processing and selecting relevant images for visual processing, organizing words into a coherent verbal model and organizing images into a coherent visual model, integrating corresponding components of the verbal and visual models" (p.3).

The need for diverse instructional strategies targeting a range of cognitive styles is echoed by the literature in learning styles, thinking styles, and individualized cognitive processes (Dunn, Dunn, & Price, 1984; kolb, 1984; Mills, 2002). Learning styles theories emphasize the unique cognitive approaches favored by individual learners and highlight the importance of providing a range of instructional strategies

to facilitate learning for all learners. However, the value of multimedia is dependent upon its appropriate use, selection, and placement (Mayer, 1997, 2001). Multimedia users are cautioned to ensure research-based principles are applied to the design and implementation of multimedia supplements.

Conclusion

Education has changed with the introduction of technology and will continue to change. It has grown from "an orderly world of disciplines and courses to an info-sphere in which technology is increasingly important" (Molnar, 1997). Clearly, the future of education will see a major change with the expansion of technology. However, that change depends on our willingness to adopt technology into educational institutions and the manner in which we as educators administer it.

References

1. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory, Englewood Cliffs, NJ: Prentice Hall.
2. Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. Educational Psycologist, **28**, 117–148.
3. Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.
4. Deci, E. L., Vallerand, R. J., Pelletier, L. C., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, **26**, 325–346.
5. Deimann, M., & Keller, J. M. (2006). Vocational aspects of multimedia learning. Journal of Educational Multimedia and Hypermedia, **15**,(2), 137–158.
6. Doolittle, P. (2001). Multimedia learning: Empirical results and practical applications. Retrieved August 26, 2011, from http://blogs.usask.ca/multimedia_learning_theory/multimedia.pdf.
7. Dunn, R., Dunn, K., & Price, G. E. (1984). Learning style inventory. Lawrence, KS, USA: Price System.
8. Efendioglu, A., & Yelken, Y.T. (2010). Programmed instruction versus meaningful learning theory in teaching basic structured query language (SQL) in computer lesson. Computers & Education, **55**(3), 1287–1299.
9. Fletcher, J.D., & Tobias, S.(2005). The multimedia principle. In R.E. Mayer (Ed.), The Cambridge Handbook of Multimedia Learning (pp. 117–133). New York: Cambridge University Press.
10. Gagne, R. M. (1965). The conditions of learning. Holt, Rinehart and Winston Inc.
11. Gagne, R. M., & Briggs, L. J. (1979). Principles of instructional design. Holt Rinehart and Winiston.
12. Hede, T., Hede, A. (2002). Multimedia effects on learning: Design implications of an integrated model. In S. McNamara and E. Stacey (Eds.), Untangling the web: Establishing learning links. Proceeding ASET Conference 2002, Melbourne, Australia. Retrieved May 21, 2011, from http://www.ascilite.org.au/aset-archives/confs/2002/hede-t.html
13. James, W. (1902). The Principle of Psychology. New York: Holt.
14. Jin, P., & Low, R. (2007). Learning motivation and E-learning performance. Unpublished manuscript, school of Education, University of New South Wales, Sydney, Australia.
15. Judge, T. A., Jackson, C, L., Shaw, J. C., Scott, B. A., & Rich, B. L. (2007). Self-efficacy and work-related performance: The integral role of individual differences. Journal of Applied Psychology, **92**(1). 107–127.
16. Kolb, D. A. (1993). LSI-IIa: Self Scoring Inventory and Interpretation Booklet. Boston: McBer & Company.

17. Kuhl, J. (2000). The volitional basis of personality systems interaction theory: Applications in learning and treatment context. International Journal of Educational Research, **33**(7–8), 665–703.

18. Low, R., & Sweller, J. (2005). The modality principle in multimedia learning. In R.E.

19. Maddux, C., Johnson, D., & Willis, J. (2001). Educational computer: Learning with tomorrow's technologies. Boston: Allyn and Bacon.

20. Mayer, R. E. (2001). Multimedia Learning. Cambridge, UK: Cambridge University Press.

21. Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? Educational Psychology Review, **8**, 357–371.

22. Mayer, R. E.(2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), The Cambridge Handbook of Multimedia Learning (pp. 31–). New York: Cambridge University Press.

23. Mayer (Ed.), The Cambridge Handbook of Multimedia Learning (pp. 147–158). New York: Cambridge University Press.

24. Molnar, Andrew R. "Computers in Education: A Brief History." Technological Horizons in Education – THE Journal, June 1997. Ebsco Host Academy-Online database under Educom Review.

25. Moreno, R., & Mayer, R. (2000). A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory. Interactive Multimedia Journal of Computer Enhanced Learning, **2**(2).

26. Murphy, C. A., Coover, D., & Owen, S.V. (1989). Development and validation of the computer self-efficacy scale. Educational and Psychological Measurement, **49**, 893–899.

27. Pajares, F. (1996). Self-efficacy beliefs in achievement setting. Review of Educational Research, 66, 543-578.

28. Pajares, F. (1997). Current directions in self-efficacy research. In M. Maehr & Pintrich (Eds.), Advances in motivation and achievement (Vol.**10**, pp. 1–49). Greenwich, C.T.: JAI Press.

29. Pintrich, P. R., & Schunk, D. H. (2002). Motivation in Education: Theory, research and applications (2nd Ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

30. Price, R. V. (1991). Computer-aided instruction: a guide for authors, Brooks/Cole, Pacific Grove California.

31. Reeve, J., Nix, G., & Hamm, D. (2003). Testing models of the experience of self-determination in intrinsic motivation and the conundrum of choice. Journal of Educational Psychology **95**(2), 375–392.

32. Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, **25**, 54–67.

33. Schunk, D. H. (1989). Self-efficacy and cognitive skill learning. In C. Ames & R. Ames (Eds.), Research in motivation in education. Vol. **3**: Goals and Cognitions (pp. 13–44). San Diego Academic Press.

34. Schunk, D. H. (1991). Self-efficacy and academic motivation. Educational Psychologist, **26**, 207–231.

35. Schwartz, J.E., & Beichner, R.J. (1999). Essential of educational technology. Boston: Allyn and Bacon.

36. Tery, L., & Khan, S. (2008). How science students can learn about unobservable phenomena using computer-based analogies. Computers & Education, **51**(2), 519–529.

37. Wigfield, A., & Eccles, J.S. (2000). Expectancy-value theory of achievement motivation, Contemporary Educational Psycology, **25**, 68–81.

38. Zweig, D., & Webster, J. (2004). Validation of multidimensional measure of goal orientation. Canadian Journal of Behavioral Science, **36**(3), 232–243.