Establishing a Solid E-learning Cognitive Threshold Leads to Practical Concrete Effect for the Future of Education

Nidal Zaki Amarin, Ph.D
Department of Educational Sciences, Faculty of Arts
Al-Zaytoonah Private University of Jordan, Jordan
namarin@alzaytoonah.edu.jo

ABSTRACT

The aim of this study is to offer an actual fulfillment by concrete consideration of current pioneer educational initiatives, and common sense familiarity, encouraging educators urgently to adopt and integrate E-learning technologies on a large scale. This study argues that it is time – in the relative absence of critical discussion – to raise questions that should precede a general implementation of E-learning. It will first provide various definitions of E-learning including Cognitive Load Theory "CLT" and instrumentalist approaches. Then it will move towards a critical theory of technology in which the discussion is broadened to a critique of promises of technology drawing on techno-positivism as a marketed ideology. The study cites research – Computer-mediated Communication "CMC" in particular – to show whether the implementation of E-learning has been able to match their promises. It calls for critical answers of how E-learning is impacting education positively, at the same time for the enrolment of teachers and/or students in exploring the relevant cultural, economic, and political contexts which can shape the future of education in a good manner.

Key words: E-learning, cognitive load theory.

INTRODUCTION

There is no doubt that E-learning and internet technologies holds great potential for improving the way that students learn. As such, learners can involve in individualised learning where they can investigate and learn concepts and content to meet their specific needs; with a combination of text, sound, animation …etc. computer technologies provides such a rich environment that traditional way of teaching and media looks insufficient and might be tedious. Techno-utopians even predict a world in which e-learning will replace face-to-face learning instruction and internet will foster learner participation and involvement in the learning process.

In the late 1990s, however this over-enthusiasm was attributed to "techno positivism" a heavily marked ideology that perpetuates a native faith in promises of technology [43] Robertson (2003, 282). Indeed, [43] Robertson (2003) claims that teachers are vulnerable to the technopositivist ideology since it addresses our desire and optimism to find quick fix, external and mechanical solutions to complex social and educational problems. [33] Monke (2005) also points out that installing computer lab in primary school may provide students with access to information in an unprecedented way but this may come at a cost of less time for art, music or physical exercise. Thus teachers need to recognize the opportunity costs and that whenever they emphasize one learning experience over another, they make decisions as to what kinds of encounters they value for today's youth, which in turn has an impact on what they grow up to value [33] Monke (2005).

THEORIES

Educational and instructional design is informed by range of theoretical positions – unfortunately, at times, with insufficient consideration of their applicability to the particular learning situation and its context. Different theoretical camps adopt distinct but overlapping explanatory frameworks, and tend to apply them to distinct but overlapping learning situations. Before considering mainstream approaches, we will dismiss a surprisingly common view which has been termed the "homeopathic fallacy" [31] McKendree, Reader, & Hammond (1995): this is that the analogous network- like structure of both the Web and the central nervous system (or, perhaps more plausibly, between the Web and associative structure of memory) somehow enhance a more direct transfer of information from computer screen to the mind. One comment will suffice to illustrate this point of view: "The book is a wonderful invention, but it has one major flaw – the linear artifact. Computers allow information to be stored and accessed relationally, thereby mimicking the central nervous system" Noblitt, cited in [31] McKendree et al., (1995). To draw the inference that this similarity is a contributor to effective learning is a little like claiming that porridge is good for learning because it looks like the gray matter of the brain. What matters is the mechanisms and processes that are brought to bear in different learning situations, not whether there is some general structural similarity, and it is to these we turn.

A cognitivist may focus largely on how individuals recruit their cognitive capabilities (memory, attention, knowledge representation, motivation … etc.) to support learning tasks e.g.,[2] Anderson (2000). This view largely adopts an acquisitional or a tutoring approach to instructional design, where an analysis of both the information to be learned and the cognitive requirements leads to appropriate sequences or procedures to optimize learning. This may, for example, be in the form of mastery learning e.g., [20] Guskey & Gates (1986) or of intelligent tutoring e.g., [25] Koedinger, Anderson, Hadley, & Mark (1997). Constructivists, on the other hand, emphasize the importance of supporting learners in constructing personal meanings for events and activities e.g., [24] Jonassen, Peck, & Wilson (1999). Learning according this view, is primarily developed through activity rather than through direct knowledge-acquisition strategies such as rehearsal. It is not hard to see the cognitivists and the constructivist share same common theoretical ground (for instance, both stress the importance of meaning and understanding): the difference is more in terms of their recipes for educational practice. For constructivist, computers are best seen as "mindtools" to help learners make activities more meaningful e.g., [29] Mayes (1992).

Educationalists in the situated learning camp place the main emphasis on the influences of the social context in which the acquired skills or knowledge are typically embedded [16]Glaser, (1990) [54] Wenger (1998). There are actually two aspects to the notion of social context, as pointed out by [5] Barab and Duffy (2000). The first is the claim that learning activity must be "authentic," and therefore situated as closely as possible in the context of real use. There are clear links here with cognitivist notions of context-dependent learning, through the situated learning view raises question about how learners can successfully abstract our general principles and avoid becoming context-bound. The second clam is that the wider context is important, and this has led to the concept of a community of practice being influential in shaping the individual's relationship with what is to be learned e.g., [54] Wenger (1998).

The cognitivist and constructivist positions are not mutually incompatible, although of course they have areas of dispute and conflict. Each may be appropriate in particular domain of study, or at different stages of learning. Quite different learning tasks may be recruited different areas of study. For example, [52] Trapp, Condron, and Hammond (1999) compared the use if information and communications technology (ITC) to support small groups in psychology departments, physics departments, and various areas of humanities. It was evident that the use of discussion as a learning method in the humanities was both far more common and largely served a different purpose (for critical analysis) than was the case in physics (where discussion sessions were rare and usually for remediation). Usage psychology departments fill between that in the humanities and that in physics. Thus, in modeling the use of the Web to support discussion in these different discipline areas, different theoretical positions will be applicable depending on the learning objectives and the material under study

Depending on the previous educationalists critical views, I present two basic theories of technology, instrumental and substantive theories before presenting the cognitive theory, which I believe the critical theory of learning.

INSTRUMENTAL THEORY

In Instrumental Theory, technology is viewed as a means to an end; technology is neutral which implies four points:

1 – Technology is indifferent to the ends it can be used to attain;

2 – Technology is not concerned with politics of societies of capitalist or socialist cultures;

3 –The rational nature of technology is the cause of technology's neutrality and the universal truth it symbolizes. This allows people to believe that because a technology works in one culture, it will work in all cultures;

4 – Because technology is neutral and it is used as a means to an end, the only rational stance is to employ it to solve any problems, regardless of the cost to environment, culture, or human beings [16] Feenberg (1991).

According to this view, technologies are seen just as "tools", standing ready to serve the purposes of their users. Thus, when technology fails or when it has negative consequences, the case is not the technology but the improper use of it by "politicians, the military, big business, and others" [38] Pacey (1983, 2). A common phrase that illustrates this perception is "Guns don't kill people. People kill people". In other words, a tool is subject to its users, it does weather the used wishes. However, this perception ignores the fact that guns, after all, were designed to kill. Therefore, they are very different from a pair of binoculars [51] Talbott (1997).

[56] Zaho et, al. (2004, 24) argue, this assumption that technologies are passive, obedient tools completely subject to the user leads to misuse, due to a lack of understanding of the forms of functions of each particular technology. Educators might feel both a false sense of empowerment and guilt especially when they see that technology fails them in achieving their intended goals because "it's up to the teachers to make good use of technology". In fact, technology is more than machinery, which maintains the existence and comfort of humankind. It is not a neutral tool; on the contrary, it is loaded with cultural values.

Computer technologies mechanism is not just an assemblage of machines and their accompanying software. It embodies a form of thinking that orients a person to approach the world in a particular way. Computer technologies involve ways of thinking that under current educational conditions are primarily technical. The more the new computer technology transforms the classroom into own image, the more technical logic replace critical, political and ethical understanding. The discourse of the classroom will center on technique, and less on substance. Once again "how to" will replace "why" [4] Apple (1991, 75). As Apple notes, a piece of software often conveys a certain teaching approach, which to a certain degree shapes that the teacher can do with it. Even the mere presence of a computer in a classroom changes the pedagogical environment. Another view of instructional theory refers to the notion that all technologies are the same, in other words, they are universal. Such attitudes ignore the fact that tools, by design, have specific qualities, each intended for specific purpose and each yielding different results [56] Zhao. et al, (2004).

Viewing computer technology as a free of pedagogical and/or philosophical bias is also problematic. Technologies are built to accomplish certain very specific goals [10] Bromley (1998). It means that some technologies might yield good results with some certain tasks but not good with others. A staircase, for example, is a great technology for people who can walk but it is undoubtedly biased against those who use wheelchairs [56] Zhao et al, (2004).

Another example is the use of visuals in educational software which is widely supported to make the learning an immersive experience where the learner uses all of his/her senses. However, research on educational psychology suggests that effective learning with visuo-spatial adjuncts is not dependent on the learner's prior knowledge and cognitive abilities [45] Schnotz (2002). Therefore, ignoring the inherent bias of technology is likely to result in incompatibility between tasks and tools as well as between pedagogy and technology [54] Zhao, Pugh, Sheldon, and Byers (2002).

CRITICAL THEORY OF TECHNOLOGY

In the beginning of the 90s, [16] Feenberg (1991) has criticized the Instrumental Theory given above and proposed an alternative view which he calls the critical theory of technology. According to Feenberg, "instrumentalist" tend to decontextualize technology, divorce it from social practices, and thus fail to provide understanding how social and historical factors have an impact on its use. He added that technology is not 'determinist', but is shaped by human agency. He also believes that technology cannot be used towards any ends people wish since technology comes with certain values/biases reflecting its own historical development and design. Therefore, the premise that technology is neutral is false [46] Schmid (2006).

In the same sense, [16] Feenberg (1991) argues that technology as contested field where individuals and social groups can struggle to influence and change technological design, uses, and meaning. In fact, one of his key contributions to theorizing technology is linking philosophical-oriented social theory of technology with theories of democratization. He argues that while technology is considered to be a major contributor to contemporary society, it is often believed that it can not exist within democracy. However, Feenberg wants to demonstrate that in fact technology can be part of a process of social democratization and technology itself can function as a means to meet basic human needs, he also believes that technologies should contribute to helping produce a more democratic and egalitarian society.

While [46] Schmid (2006) explain, a critical theory of technology considers that each piece of technology is constructed by the interaction between its design and how it appropriated by its users. Thus, technology, teacher's pedagogical beliefs and the kind of pedagogical activities that were designed as a result of them, students' own understandings of the potential of the technology and the negotiations between students and the teacher regarding how technology should be pedagogically exploited.

[19] Goldberg and Riemer (2006) describe, from a critical theory perspective, the emergence and growing popularity of online distance education. They argue that online learning has failed to address the additional burdens on faculty members, who struggle with the expanded time commitment required to convert a class to an online format and to attend to students who demand the immediate attention of faculty members to solve their technology-related problems. However, they note that administrators have given little to no consideration to the displacement of teacher in an online environment that has a preference for substituting 'delivery' for 'teaching'.

COMPUTER TECHNOLOGIES AND COGNITIVE THEORY

According to [51] Tiwari (2008) "Cognitive apprenticeships take many forms, but the two key components are social interactions to allow students to work on problems that may be too difficult for them to handle individually, and a focus on real world problems using real-world tools." (p. 160).

Therefore, educational software should make sense from a pedagogical point of view. Hence, four crucial considerations should govern the design of machine-supported instructional contexts: (a) a cognitive and instructionally efficient model of the task or the domain the system is designed for, (b) a sound conception of the general and content-specific learning processes associated with the domain, (c) a domain-appropriate social-cognitive concept of teaching (balancing dimensions such as explicit instruction versus discovery learning, "solo-learning" [11] Bruner (1961), [12] Bruner (1986) versus collaborative learning), and (d) a view of active nature of the learner. With regard to the tutoring of mathematical word problems; whoever designs a computer-based instructional system needs to know both how to effectively represent and convey the informational structures related to word problems and the processes and strategies employed by learners of different ability level in their understanding and problem solving.

Thus work on tutoring systems should be based on research in cognitive psychology and on research in didactical or instructional theory, two distinct fields, which still maintain few interconnections. Often enough, cognitive researchers analyze meaning structures and processes on a conceptual level, using formats that are neither translatable into instructionally efficient models of domains and tasks, nor allow inference to any normative principles, [17] Glaser (1987) of instruction. On other hand, designers of textbooks and computational media, as well as (expert) teachers, are often not successful in performing micro-structural cognitive task analyses, yet such analyses would be beneficial in uncovering the properties of the representational and operative "tacit" [39] Polanyi (1966) knowledge inherent in the performance of a task. In contrast to a technology-driven and opportunistic design philosophy, computers should be used in education, by judicious and active, international earners (in the sense of [44] Scardamalia, Bereiter, McLean, Swallow, and Woodruff (1989) as cognitive supportive tools in the service of explicit pedagogical goals [42] Reusser (1991). As mind-empowering prosthetic devices which belong to our overall "cultural tool kit" [13] Bruner (1990), future computerized tools of learning and instruction not only act as amplifiers of our own intelligence but, beyond that, might significantly change our traditional view of the instructional view setting, "redefine the natural limits of human functioning," as [13] Bruner says (1990, p, 21).

While the catchword "intelligent tutoring systems" [47] Sleeman & Brown (1982) has come to mean that a computer functions as an intelligent, dynamically adaptive substitute for a human teacher, who is capable of performing sensitive cognitive diagnoses, which means to infer , on the basis of a constantly- retuned student model, a person cognitive states – what the person knows, how she thinks and learns – on the basis of her overt behavior [35] cf. Ohlsson (1986); [52] van Lehn, (1988). There are good reasons to be skeptical about the feasibility – and in part even the desirability – of intelligent systems that are based on full system control and deep student modeling [34] Nathan, Kintsch, & Young (1990); [41] Resnick & Johnson (1988); [44] Scardamalia et al. (1989). Intelligent tutoring, in which a machine tailors its instruction to an individual student on the basis of an inferred, constantly updated, fine-grained mental model, may be seen as a long-term goal. But given the current state of the art, machine-tutoring based on cognitive simulation of the student is not possible across a full range of open-ended tasks and domains, where fuzzy language and qualitative world-knowledge based reasoning are required. Thus is especially true with regard to error modeling. As [14] Derry and Hawkes (1989) note: "Deep modeling of procedural bugs is computationally intractable for complex problem domains, and we do not believe it is required for effective cognitive apprenticeship" (p. 33).

In computer-based apprenticeship, the cognitive coach can model correct problem-solving actions and procedures, and support the student in performing complex tasks. Coached learning environment vary according to when support is given – i.e., either the system intervenes when it recognizes that the student needs help e.g., [3] Anderson & Reiser (1985); [40] Reiser, Kimberg, Lovett, & Ranney (1992), or remains a silent observer until the student asks for help e.g., [26] Lesgold, Lajoie, Bunzo, & Eggan, (1992). In either case, support fades as the student comes to master the task.

More recently, some system designers have incorporated another crucial aspect of apprenticeship learning within their tutors: the opportunity to review one's performance with an expert, or "master" [26] Lesgold, Lajoie, Bunzo, & Eggan (1992). Psychological experimentation [37] Owen & Sweller, (1985); [48] Sweller (1988); [49] Sweller & Cooper (1985) and theoretical models of case-based learning e.g., [32] Mitchell, Keller, & Kedar-Cabelli (1986) indicate why a review phase is important for acquiring cognitive skills.

Cognitive approaches, on the other hand, emphasize learning as a process, and the role of the student in mediating learning. The learner organizes knowledge and meaning by modifying mental representations. The metaphor of the information processing system is often used to illustrate this process. Essentially, information is selected from the environment and placed in a temporary buffer called working (or short-term) memory. Once selected, the information is subsequently either discarded or processed more completely. Encoding occurs when new and existing information is integrated in working memory and transferred into long-term (permanent) memory [21] Hannafin (1989).

Long-term memory comprises schemata, which are organized networks of related knowledge. Each schema provides slots are instantiated, or filled, mediates comprehension. Furthermore, schemata provide a framework within which related, but unfamiliar, knowledge maybe subsumed. Consequently, schemata are constantly refreshed and restructured through new knowledge, while additional connections among related schemata are made. Retrieval, for both responding and restructuring with new knowledge, requires action among various related schemata which are cued based upon ongoing cognitive demands; cognitive approaches emphasize strategies that foster meaningful learning and regulate the flow of information among the environment, working memory, and long-term memory [22] Hannafin & Rieber (1989).

Finally, educational aims in terms of learning outcomes are often described in terms of three major domains-affective, cognitive, and psychomotor. The cognitive domain includes recall of knowledge of various types and intellectual skills and abilities, such as analysis, synthesis, and evaluation [6] Bloom (1956). The effective domain includes such abilities as receiving (attending), responding, and valuing. The psychomotor domain includes such activities as attending to and selecting from sensory stimuli, imitating acts, and performing motor tasks.

CMC AND INDIVIDUAL DIFFERENCES

A consistent finding reported by faculty who have redesigned their courses around learning technologies is that there are surprising individual difference in students' tendencies to benefit from the technologies e.g., [36] Oshima & Scardamaila (1996). Therefore, prior knowledge should predict learners' ability to benefit from technologies that emphasize conceptual understanding of material and learning outcomes that involve creative transfer. This prediction is based on the finding that prior knowledge increases students' ability to derive meaningful representations of learned material. The second dimension, verbal versus visual learning style, should predict students' ability to benefit from technologies that add rich visual support to traditional text material and/or face-t-face learning instruction. The third factor, cognitive flexibility, should predict learners' ability to benefit from just about any technology that departs from familiar classroom learning environment – especially technologies that involve radical departures from traditional instructional approaches (e.g., electronic evidence that is consistent with the first two predictions is available from studies of multimedia environment e.g., [29] Mayer (1997), and some evidence that is consistent with the third prediction is available from hypertext environments e.g., [23] Jacobson & Spiro (1995).

Global relations among technological interventions, individual differences, memory contents, and learning outcomes can be captured in structural equation models. However, underlying detailed process models should also be developed using Markov models for recursive learning processes (e.g., memory retrieval). The structure of such models can be briefly characterized as follows [8] cf. Brainerd & Reyna (1995); [9] Brainerd et al., (1990). The effects of technology-infused instruction of learning outcomes are indirect. They are modulate by two classes of factors, one that is proximal learning outcomes and the other that it is more distal to learning outcomes. The proximal class of factors is the nature of the memory representations, verbatim and gist, that are acquired on the basis of technology-infused instruction. The distal class of factors consist of stable individual differences variables of two sorts, cognitive and social-personality. These individual differences factors will also affect the content of memory representations, so model-based representations of research findings should be interactive at the level of proximal versus distal controlling factors.

CONCLUSIONS

In this paper, it was discovered (from the literature) that, earlier interest in computer support for collaborative learning has led to several technological innovations. Cooperative learning and computer-supported intentional learning environments have strong roots in the cognitive field psychology of Kurt Lewin. Learning settings that would be described as cooperative structures may be differentiated from those that are competitive or individualistic. While other cognitive psychology theories have been influential (Piaget & Vygotsky), the primary focus of this paper has been to describe issues regarding group processes.

In addition, applied social psychological strategies for learning in highly diverse school environments were inspired by the earlier research of [15] Morton Deutsch (1949), who demonstrated the positive effects of promotive interdependence, that is, cooperative learning. Learning settings that could be described as cooperative structures can be defined and differentiated from those that are competitive or individualistic.

Where should we go now as a field? First, we should examine the assumptions that underlie the theories upon which our field is based. Turning toward a view of knowledge as constructed requires a major re-conceptualization of our assumptions and practice. But even if such a view is ultimately rejected, we should not delay a full analysis of the assumptions that support our field. In those situations where assumptions lack consistency, we should adopt a consistent set of assumptions and reject the findings of research and the development of theory based on different assumptions. We should constantly reexamine our assumptions in light of new findings about learning.

As teachers, parents, educators and administrators, we should ground ourselves in theory. One of the practices that requires scrutiny in the practice of drawing from the fields with different theoretical bases without examining the conflict between the basic assumptions of those theories. Optimally, we would tie our perceptions for learning to a specific theoretical position – the prescriptions would be the realization of a particular understanding of how people learn. Minimally, we must be aware of the epistemological underpinning of our instructional design and we must be aware of the consequences of that epistemology on our goals for instruction, our design of instruction, and the very process of design.

Therefore, within a critical cognitive theory of technology perspective, and research literature is to encourage teachers, administrators and parents to start implementing eLearning applications. One should therefore not conceive of eLearning applications in education primarily as substitutes for intelligent teachers but as tools aimed at cultivating the intelligence of the user, as didactic instruments, directed, to the greatest possible extent, at fostering learner autonomy and self-regulation. Such a perspective would provide us with a more comprehensive analysis of the social and pedagogical issues that would otherwise be gone unnoticed.

Only in this way we can have a full picture of the process of technology integration and make judgments about the applicability of the findings to other contexts. I believe that integrated eLearning as a cognitive tool can prove a useful framework and might stimulate the development of future studies taking into account the important link between cognition, knowledge, and interaction. An understanding of the inherent integration of cognition, knowledge, and social interaction is also necessary if eLearning and/or web-based learning tools are to live up to their potential.

REFERENCES

[1] Ackerman, P. L. (1988). Determinates of individual differences during skill acquisition: Cognitive abilities and information processing. *Journal of Experimental Psychology: General,* 117, 288-318.

[2] Anderson, J. R. (2000). *Learning and memory*. New York: Wiley.

[3] Anderson, J. R., & Reiser, B. J. (1985). The LISP tutor. *Byte, 10*(4), pp. 159-175.

[4] Apple, M. W., (1991). The new technology: is it part of solution or part of problem in education? *Computers in the Schools,* 8 1/2/3, 59-81.

[5] Barab, S., & Duffy, T. (2000). From practice fields to communities of practice. In D. H. Jonassen & S. Land (Eds.), *Teoritical foundations of learning environments* (pp. 25-55). Mahwah, NJ: Erlbaum.

[6] Bloom, Benjamin S, (ed.). *Taxonomy of Educational Objectives, the Classification of Educational Goals, Handbook 1: The Cognitive Domain*, David McKay Co., Inc., New York, 1956.

[7] Brainerd, C. J., & Reyna, V. F. (1990). Inclusion illusions: Fuzzy-trace theory and perceptual salience effects in cognitive development. *Developmental Review,* 10, 365-403.

[8] Braierd, C. J., & Reyna, V. F. (1995). Autosuggestibility in memory development. *Cognitive Psychology,* 28, 65-101.

[9] Braierd, C. J., & Reyna, V. F., Howe, M. L., & Kingma, J. (1990). The development of forgetting and reminiscence. *Monographs of the Society for Research in Child Development,* 53, (3-4, Serial No. 222).

[10] Bromley, H. (1998). Introduction: Data-driven democracy? Social assessment of educational computing. In H. Bromley & M. Apple (Eds.), *Education, Technology, Power* (pp. 1-28). Albany, NY: SUNY Press.

[11] Bruner, J. (1961). The act of discovery. *Harvard Educational Review, 31*, 21-32.

[12] Bruner, J. (1986). *Actual minds, possible worlds.* Cambridge, MA: Harvard University Press.

[13] Bruner, J. (1990). *Acts of meaning.* Cambridge, MA: Harvard University Press.

[14] Derry, S. J., & Hawkes, L. W. (1989). *Error-driven cognitive apprenticeship: A feasible ITS approach.* Florida State University, Tallahassee.

[15] Deutsch, M. (1949). A theory of cooperation and competition. *Human Relations,* 2, 129-152.

[16] Feenberg, A., (1991). *Critical theory of technology.* New York and Oxford: Oxford University Press.

[17] Glaser, R. (1987). The study of cognition and instructional design: Mutual nurturance. *Behavioral and Brain Sciences,* 10, 483 – 84.

[18] Glaser, R. (1990). The re-emergence of learning theory within instructional research. *American Psychologist,* 45, 188-195.

[19] Goldberg, A. K., & Riemer, F. J. (2006). All Abroad – Destination Unknown: A Sociological Discussion of Online Learning. *Educational Technology & Society,* 9 (4), 166-172.

[20] Guskey, T. R., & Gates, S. (1986). Synthesis of research on the effects of mastery learning in elementary and secondary classrooms. *Educational Leadership,* 43, 73-80.

[21] Hannafin, K. M. (1989). Interaction strategies and emerging instructional technologies: Psychological perspectives. *Canadian Journal of Educational Communication, 18*(3), 167-179.

[22] Hannafin, M. J., & Rieber, L. P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies. Part I & II. *Educational Technology Research and Development, 37*(2), 91-114.

[23] Jacobson, J., & Spiro, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer to complex knowledge: an empirical investigation. *Journal of educational Computing Research*, 12, 301-333.

[24] Jonassen, D. H., Peck, K. L., & Wilson, B, G. (1999). *Learning with technology: A constructivist approach.* Upper Saddle River, NJ: Prentice-Hall.

[25] Ködinger, K. R., Anderson, J. R., Hadley, W. H. & Mark, M (1997). Intelligent tutoring goes to school in the big city. *International Journal of Artificial Intelligence in Education,* 8, 30-43.

[26] Lesgold, A. M., Lajoie, S. P., Bunzo, M., & Eggan, G. (1992). Sherlock: A coached practice environment for an electronics troubleshooting job. In J. Larkin & R. Chabay (Eds.), *Computer assisted instruction and intelligent tutoring systems: Shared issues and complementary approaches.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[27] Lewin, K. (1948). *Resolving social conflicts: Selected papers on group dynamics.* New York: Harper & Row.

[28] Luppicini, R. (2007). Review of computer mediated communication research for education. *Instructional Sciences,* 35, 141-185.

[29] Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist,* 32, 1-19.

[30] Mayes, J. T. (1992). *Cognitive tools: A suitable case for learning.* In P. A. M. Kommers, D. H. Jonassen, & J. T. Mayes ((Eds,), Cognitive tools for learning (pp. 7-18). Berlin: Springer-Verlag.

[31] McKendree, J., Reader, W., & Hammond, N. (1995). The “homeopathic fallacy” in learning from hypertext. *Interactions,* 2, 74-82.

[32] Mitchell, T. M., Keller, R. M., & Kedar-Cabelli, S. T. (1986). Explanation-based generalization: A unifying view. *Machine Learning,* 1, 47-80.

[33] Monke, L. (2005). Charlotte’s webpage: Why children shouldn’t have the world at their fingertips. *Orion, 24 (5), 24-31.*

[34] Nathan, J. N., Kintsch, W., Young, E. (1990). *A theory of algebra word problem comprehension and its implications for unintelligent tutoring systems* (Technical Report 90-02). Institute of Cognitive Science, University of Colorado, Boulder.

[35] Ohlsson, S. (1986). Some principles of intelligent tutoring. *Instructional Science,* 14, 293-326.

[36] Oshima, J., & Scardamalia, M. (1996). Collaborative learning processes associated with high and low conceptual progress. *Instructional Science,* 24, 125-155.

[37] Owen, E., & Sweller, J. (1985). What do students learn while solving mathematics problems? *Journal of Educational Psychology,* 77, 272-284.

[38] Pacy, A. (1983). *The Culture of Technology.* Basil Blackwell.

[39] Polanyi, M. (1966). *The tacit dimension.* London: Routledge & Kegan.

[40] Reiser, B. J., Kimberg, D. Y., Lovett, M. C., & Ranney, M. (1992). Knowledge representation and explanation in GIL, an intelligent tutor for programming. In J. Larkin & R. Chabay (Eds.), *Computers assisted instruction and intelligent tutoring systems: Shared issues and complementary approaches.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[41] Resnick, L. B., & Johnson, A. (1988). *Intelligent machines for intelligent people*: *Cognitive theory and the future of computer-assisted learning*. Pittsburgh: Learning Research and Development Center.

[42] Reusser, K. (1991, August). *Intelligent technologies and pedagogical theory: Computers as tools for thoughtful teaching and learning.* Invited address at the Fourth Conference of the European Association for Research on Learning and Instruction (EARLI) Turk, Finland.

[43] Robertson, H.J. (2003). Toward a theory of negativity: Teacher education and information and communications technology. *Journal of Teacher Education, 54 (4), 280-296.*

[44] Scardamalia, M., Bereitier, C., McLean, R. S., Swallow, J., & Woodruff, E. (1989). Computer-supported international learning environments. *Journal of Educational Computing Research,* 5, 51 – 68.

[45] Schnotz, W. (2002). Toward an integrated view of learning from text and visual displays. *Educational Psychology Review,* 14 (1), 101-120.

[46] Schmid, C. (2006). Investigating the Use of Interactive Whiteboard Technology in the English Language Classroom through the lens of a Critical Theory of Technology. *Computer Assisted Language Learning,* 19, (1), 47-62.

[47] Sleeman, D., & Brown, J. S. (1982). *Intelligent tutoring systems.* New York: Academic Press.

[48] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science,* 12. 257-285.

[49] Sweller, J., &Cooper, G. (1985). The use of worked examples as a substitute for problem solving in algebra learning. *Cognition and Instruction,* 2, 58-89.

[50] Talbott, S., (1997). Do computers Kill People? (Issue: Netfuture #37), http://www.ora.com/people/staff/stevet/netfuture/1997/Jan0897_37.html

[51] Tiwari, D. (2008), *ENCYCLOPAEDIC DICTIONARY OF EDUCATION*, New Delhi: Crescent Publishing Corporation.

[52] Trapp, A., Condron, F., & Hammond, N. (1999). Using C&IT to support small-group learning activities in psychology. In *Proceeding of Association for Learning Technology Conference* (ALT-C99). Oxford: Association for Learning Technology.

[53] Van Lehn, K. (1988). Student modeling. In M. Polson & J.J. Richardson (Eds.) *Foundations of intelligent tutoring systems.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[54] Wenger, E, (1998). *Communities of practice: Learning, meaning and identity.* Cambridge: Cambridge University Press.

[55] Zhao, Y., Pugh, K., Sheldon, S., & Byers, J.L. (2002). Conditions for classroom technology innovations. *Teachers College Record,* 104 (3), 482-515.

[56] Zhao, Y., Alvares-Torres, M., Smith, B., Tan. H. S. (2004). The Neutrality of Technology: A Theoretical Analysis and Empirical Study of Computer Mediated Communication Technologies. *Journal of Educational Computing Research,* Vol. 30 (1&2) 22-55.