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AUTHOR	Kovalik, Cindy L.; Dalton, David W.	
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ABSTRACT

The adoption of alternative pedagogical philosophies in the classroom has led to an increased use of technology to expand and enhance authentic, contextual learning environments. Correspondingly, these new approaches have also led to a growing dissatisfaction with existing evaluation methodologies to evaluate knowledge. This paper proposes such an evaluation model based on the premise that evaluation strategies should reflect the full range of the experiences of learning. The model incorporates evaluation strategies that provide a composite picture of learning by examining both the learning process and the learning outcome. Dubbed the Process/Outcome Evaluation Model (POEM), the model expands and integrates existing evaluation models by providing the tools that can help decode, interpret, and assess not only what is learned, but also how the learning occurred. The evaluation matrix of POEM contains four categories of measurements: hard-outcome, hard-process, soft-outcome, and soft-process. By analyzing data from each measurement component singly, then collectively, evaluation using POEM becomes more comprehensive than traditional outcome-based testing strategies. (Contains 47 references.) (AEF)

A Conceptual Framework for Assessment: The Process/Outcome Evaluation Model

Cindy L. Kovalik
David W. Dalton
Kent State University

Abstract

The adoption of alternative pedagogical philosophies in the classroom has led to an increased use of technology to expand and enhance authentic, contextual learning environments. Correspondingly these new approaches have also led to a growing dissatisfaction with existing evaluation methodologies to evaluate knowledge. In this paper the Process/Outcome Evaluation Model (POEM) is proposed to guide in the development of more holistic evaluations of both the learning process and the resultant outcomes of that process. POEM consists of four components that employ multiple evaluation techniques and strategies resulting in a composite assessment of the totality of a learning experience.

Introduction

Traditionally, evaluation consists of a measurable test of learner knowledge, usually based on specified or implied learning objectives (Carey, 1988). On test day the learner is placed into an artificial testing environment, with no access to resources, and asked to answer a series of questions. Test results are calculated, compared to acceptable levels of performance, and assigned a grade or ranking. This measure of knowledge essentially evaluates only one dimension of knowledge; the ability of the learner to reproduce, recall, or recognize the teacher's or test designer's knowledge (Choi & Hannafin, 1995). In this scenario, what is learned is determined by what is measured (Jonassen, 1996) and since the assessment procedures are restrictive in scope, the learning outcomes and processes are commensurately limited.

In order to reflect the multifaceted nature of learning, many educators believe assessment should encompass more than a single dimension of learning (Engel, 1994). This expanded view of evaluation is often referred to as authentic, performance-based evaluation (Darling-Hammond, 1994b). Traditional evaluation is described as secretive (Wiggins, 1989), expedient (Engel, 1994), and decontextualized (Jonassen, 1991), concentrating on discrete facts and rewarding convergent thinking. In contrast, authentic evaluation is seen as public (Wiggins, 1989), cumulative (Engel, 1994), and contextualized (Jonassen, 1991), integrating disciplines and enabling the learner to create original and unique problem solutions. However, even with authentic evaluation, educators are still confronted with the question of how to assess the *totality* of learning.

This paper proposes an evaluation model based on the premise that evaluation strategies should reflect the full range of the experiences of learning. The model incorporates evaluation strategies that provide a composite picture of learning by examining both the learning process and the learning outcome. Termed the Process/Outcome Evaluation Model (POEM), the model expands and integrates existing evaluation models by providing tools that can help decode, interpret, and assess not only what is learned, but also how the learning occurred.

Evaluation, Alternative Pedagogies, and Technology

The continuous and cyclical nature of educational testing makes evaluation pervasive and significant for learners and educators. Even though tests serve multiple purposes, including assessing student knowledge, teacher/lesson effectiveness, and curriculum content (Carey, 1988), evaluation results most directly effect learners. Test scores are used to allow or deny access to educational opportunity.

Learners are effected by decisions made based on test results that shape their educational future and by a curriculum that is dictated by test content. Since the focus is often achievement of specified test results, evaluation results can become the driving force behind educational strategies (Worthen & Spandel, 1991). Levels of test achievement frequently define what is taught (Haney & Madaus, 1989).

While supposed or real deficiencies in basic skills or knowledge may be overcome through emphasis on traditional subjects such as reading, writing, and computation, critics of the current educational system argue that students are unable to apply knowledge and skills learned in school to nonschool situations (see, for example, Brandt, 1993). In other words, some educators question whether schools are teaching the skills necessary for the work of scientists, mathematicians, artists, engineers, writers, educators, and the other professionals (Resnick, 1987).

Constructivist theories of learning recognize the learner as chief architect of knowledge creation through the application of unique experiences and beliefs to the learning process. Alternative pedagogies based on these assumptions focus on the individual while fostering skills in higher-order thinking and problem-solving strategies.

Salient features of constructivist learning approaches include an emphasis on a) authenticity (Brown, Collins, & Duguid, 1989; Cronin, 1993); b) group work (Savery & Duffy, 1995; Slavin, 1991; English & Hill, 1994); c) learner definition and control of the learning experience (Jonassen, Campbell, & Davidson, 1994; Kinzie & Sullivan, 1989); d) the teacher as guide, facilitator, coach (Cognition &Technology Group at Vanderbilt, 1993); e) divergent learning outcomes (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990); and f) the use of supportive learning environments that are, in themselves, authentic, ecologically valid, and learner-centered (Krovetz, Casterson, McKowen, & Willis, 1993; Newmann & Wehlage, 1993; Stepien & Gallagher, 1993; Morrison & Collins, 1995; Wilson, 1995; Laszlo & Castro, 1995). Frequently, the use of ill-structured, unresolved social problems such as devising a solution to the nuclear waste problem form the basis of constructivist learning environments (Stepien & Gallagher, 1993) where learner solutions are evaluated not by their adherence or nonadherence to factual data, but by how well the solution solves the problem being investigated.

Technology figures prominently in these learning environments since technology enables both knowledge exploration (Jonassen, 1988; Locatis, Letourneau, & Banvard, 1989; Marchionini, 1988) and knowledge creation (Harris & Cady, 1988; Jonassen, 1988; Jonassen, 1996; Lehrer, Erickson, & Connell, 1994) without the traditional reliance on teacher and textbook as primary providers of knowledge. Technology is adaptable to less traditional educational purposes including individual learning, hypermedia development, and information exploration. In addition, technology can facilitate evaluation by gathering continuous information of learner progress, providing a readily usable storage device for evaluation results, and creating realistic microenvironments where learners are asked to solve problems that mirror reality.

The incorporation of alternative pedagogical models has begun to shift the emphasis away from simple, one-shot evaluation measurements to a broader array of assessment methodologies. Alternative forms of evaluation tend to encourage the use of multiple vehicles for showcasing student achievement including portfolios, skill demonstrations, student performances, artistic works, and computer-related projects.

Although much attention has been directed to alternative forms of evaluating student progress (Darling-Hammond, 1994a; Darling-Hammond, 1994b; Engle, 1994), educational evaluation, in practice, still generally focuses on only one dimension of learning; the learning outcome. Evaluating the learning process must also be an integral part of evaluation strategies (Choi & Hannafin, 1995; English & Hill, 1994; Jonassen, 1991; Jonassen, 1996; Kumar, 1994; Kumar, Helgeson, & White, 1994; Marchionini, 1988; Webb, 1995).

Evaluation of Learning Process and Learning Outcome

Jonassen (1988) defines learning as the reorganization of cognitive structure, or, the expansion of the learner's semantic network. This definition implies that learning produce divergent, not convergent learning outcomes. Further, if divergent learning best occurs when learners are able to incorporate new information into their preexisting semantic networks, then allowing learners to determine how best to learn may be preferable to over-structuring that experience for the learner (Kinzie & Berdel, 1990).

One way learners structure their learning experience is by exercising control over various lesson attributes including instructional sequence, pacing, and options. Learner control removes the learner from a prescribed, regimented, predetermined lesson sequence and allows freedom of movement in and between lesson components. This freedom often enables the learner to structure the learning experience in a way that may best facilitate fusing new information with preexisting knowledge.

Learning can be differentiated into learning processes, or *how* the learning occurs, and learning outcome, or *what* is learned. The strategies and mental processes used for learning differ from what is learned. Learning processes are internal, unique to the learner, and difficult to evaluate with traditional testing instruments (Kumar, et al., 1994). Learning outcomes, on the other hand, can be externalized by the learner and are normally seen as a product of the learning situation. Learning outcomes can be as simple as the learner's performance on a forced-choice test, or as elaborate as a learner-generated hypermedia program. Learning outcomes are generally more easily evaluated than learning processes since outcomes are tangible and processes tend to be subtle and often idiosyncratic.

Separating "hard," statistically measurable, reliable, and valid evaluation criteria from "soft," interpretive, aesthetic, and affective evaluation criteria provides a classification system to evaluate outcome and process in two dimensions. The resulting evaluation matrix contains four categories of measurements: hard-outcome, hard-process, soft-outcome, and soft-process. These four measurements comprise the framework of the Process/Outcome Evaluation Model (POEM) (see Figure 1). By analyzing data from each measurement component singly, then collectively, evaluation using POEM becomes more comprehensive than traditional outcome-based testing strategies. Evaluation takes on a broader perspective, investigating and synthesizing the totality of the learning experience. In the sections that follow, each quadrant of POEM will be described and examples of each evaluation type provided.

Figure 1. The Process/Outcome Evaluation Model

Process/Outcome Evaluation Model

	Hard Measurable, reliable valid data	**Soft** Interpretive, aesthetic, affective data
Outcome What has the learner produced?	Criterion-referenced tests Norm-referenced tests Juried evaluation Performance checklist Skill demonstration	Observations - learner attitude - motivation - branching of inquiry Generalizable skills/Transfer Portfolios/Exhibitions Performances Oral exams Self-critique/Reflection Debating/Advocacy Final production
Process What is the learner doing?	Frequency counts - conversations - use of help screens - facial expressions/body language Time on task Audit trails Results from adaptive instructional systems Record of adherence to protocol	Observations - facial expressions/body language - learner interactions - consultation with teacher/expert Metacognition skillfulness Access to ancillary materials Journaling Knowledge engineering Apprenticeship - production iterations - skill building

Hard-Outcome Evaluation

Learning outcomes are tangible representations of what the learner has learned. In today's educational climate, a learning outcome can be a multiple-choice test, an essay, a collaborative oral report, a written report, an art project, or any number of products or performances that adequately measure mastery of the goals and objectives of the learning experience.

The hard-outcome evaluation component will contain answers to questions that are driven by learning objectives and whether or not the learner achieved a satisfactory level of knowledge acquisition or demonstratable skill. A wide variety of tests can be employed ranging from forced-choice tests, to criterion checklists containing relevant skills for specific activities, to criteria for observational tasks, to problem-specific rubrics.

Criterion- and norm-referenced tests are typical hard-outcome instruments. However, the tendency to envelop testing situations in secrecy where test takers receive little information prior to the test and minimal feedback on test results hinders open discussion about test content and test outcomes (Wiggins, 1989), thereby limiting their value as evaluative measurements (Berliner, 1992).

An added dimension to hard-outcome evaluation is the use of multiple evaluators, resulting in juried evaluations of products, such as portfolios. Along with improved reliability and validity produced by multiple raters, learners can be exposed to multiple sources of feedback and criticism. In this way, evaluation becomes a partnership where learners continue with the learning process as cognitive apprentices.

Hard-Process Evaluation

Hard-process evaluation consists of gathering and analyzing objective, quantifiable data on how learning occurs. Examples include counting the number of times a learner attempts a problem solution; tallying the number of interactions between students; tracking how often students follow prompts, guidance, and suggestions; and recording the learner's path through instructional materials.

Teachers often gather hard process data formally or informally by tabulating learning conditions and learning readiness in their classrooms. A teacher may categorize the types of questions being asked in order to induce where learners are in the learning process. Constant reference to printed material, quizzical looks, and student conversations are other examples of actions educators can count to aid in evaluating the learning process. The use of technology can greatly facilitate hard-process evaluation. If, for example, hypermedia is selected as part of the instructional medium, audit trail data provides insight into questions concerning the breadth and depth of a learner's path, time spent at each learning activity, number of times an activity is accessed, and how often program features such as notebooks, help screens, and scrapbooks are accessed. Collection of hard process data not only contributes to individual learner profiles, but also assists in analyzing lesson strengths and deficiencies.

The collection of quantifiable data for path analysis is relatively simple within a hypermedia environment. However, path analysis tends to produce large amounts of data per individual learner, and unmanageable datasets for groups of learners. If audit trail data is used to analyze the learning process, then methods to organize the massive amounts of audit trail data collected must be defined.

Misanchuk and Schwier (1992) offer four ways to represent quantitative audit trail data including audit trail trees, where multiple paths are successively layered on a side-ways tree-like structure, visually reflecting commonalities between learner paths, with the most commonly accessed paths appearing as the thickest branches.

Flynn (1994) used audit trail data to discern "navigational styles" of learners. By recreating and comparing paths across learners, four broad categories of navigational styles were identified: a) browsers, b) explorers, c) investigators, and d) novices. Each navigational style was defined by how learners accessed program components. For example, a learner who consistently moved randomly in the hypermedia lesson was classified as a "novice," whereas learners who went back to screens or activities already accessed and then systematically delved deeper into a specific category were classified as "investigators" (Flynn, 1994).

Based on actual user interaction, audit trail data is valid, measurable, and reliable. The hard-process evaluation strategies based on hypermedia-related audit trail path analysis provide meaningful measurements about the learner's journey through hypermedia in a quantifiable way.

Technology-based observations accomplished through adaptive instructional systems rely on the computer's pre-programmed ability to interpret learner responses to allow for diagnostic assessment and continuous advisement (Tennyson, 1984). This approach results in lesson sequences tailored to the individual learner. Lesson options are determined by a historical interpretation of what a specific learner has done and is likely to do. Adherence to and deviation from prescribed sequences can be tracked and analyzed as part of hard-process evaluation strategies.

Soft-Outcome Evaluation

Soft-outcome evaluation encompasses the subjective assessment of learner-generated products and the experience in total. These evaluation strategies include criterion checklists, expert appraisal, and self-reflection. In general, for soft-outcome evaluation to be valid, products must reflect the outcome of solving authentic tasks. A portfolio containing an array of products focusing on the solution to a problem is one example of the type of outcome evaluated through soft-outcome strategies.

Soft-outcome evaluation relies on the expertise and complexity of human evaluative interactions. Engagement in ongoing, evaluation-driven dialogue needs to occur between learner and evaluator, between learner and groups of raters and critics, between learner and peers, and between learner and experts. These interactions should assess learner conceptual understanding through the provision of meaningful and pertinent guidance and advice. Learners and their peers, for example, should establish ways to build on each other's strengths while striving to improve areas of weakness. Learners also need to be given time and encouraged to reflect on the learning activity, focusing on what worked and what did not, unresolved questions, and how this learning experience may transfer to other problems.

Historically, the competitive nature of schooling stifles evaluative dialogue. Learners are usually motivated to out-perform their peers, not to help them do better. The use of strategies such as cooperative and collaborative learning can help foster discussion in the classroom about the importance of understanding and defining the problem to the solved, attributes of problem solving strategies, consequences of planning or not planning activities, and the efficiency and effectiveness of various problem solutions. These discussions, while evaluative in nature, do not emphasize the correctness of a problem solution, but rather stress the strengths and weaknesses of solutions when viewed from multiple perspectives.

Another emphasis of soft-outcome evaluation is assessing learner ability to move onward. Questions to be pursued in this regard need to be contextually sensitive, reflective of a particular learning activity. Has the learner demonstrated the desire or inclination to broaden the inquiry? Can the learner actively and effectively debate a position or belief? What motivates this particular learner? What has the learner done to self-critique his/her experience? Combining observation and conversation to derive answers to these questions gives educators a solid foundation from which to draw inferences about learning outcomes.

Soft-Process Evaluation

Soft-process evaluation strategies employ qualitative measurement techniques. The process of learning is internal and often difficult to evaluate without involving the learner in some type of dialogue about what he or she is doing, or has done while in a learning situation and why these activities were chosen. For example, correlating learner activity with stated intentions during a problem-solving activity can help identify rationales for learning decisions and clarify the learning process (Kumar, et al., 1994).

Kumar (1994) focused on how hypermedia can be used as a "tool for following the learner's cognitive processes" (p. 60), and thus evaluate how learning occurs. Kumar (1994) suggests using the navigational path as the basis for understanding the learner's problem-solving process since it reflects all the choices and decisions made by the learner while solving a problem.

Soft-process evaluation strategies help assess what learners are doing while actively engaged in a learning situation. Observational skills are critical in order to better discern and interpret activities such as student interactions; the use of ancillary materials, such as reference books and notepads; and the iterations involved in building and refining skills, such as when students create multiple versions or drafts of a project or paper en route to a finished product. Observing learner behaviors, talking with learners about what is observed, and encouraging learners to identify when, where, and why they made specific choices all contribute to evaluation. In this sense, learner behavior is used to infer how the learner is learning.

Additionally, soft-process evaluation strategies are congruent with knowledge engineering, where post-instructional changes in a learner's semantic network are discussed and interpreted (Jonassen, 1996). Comparing a learner's semantic network over time highlights the complexity and interrelatedness of ideas and concepts. Computerized tools are available that create a graphical representation of a semantic network, often called a "cognitive map" (Fisher, 1990; Jonassen, 1996). A cognitive map represents ideas or concepts as nodes filled with text and/or graphics, and relationships or "links" between ideas and concepts are represented by appropriately labeled lines (Jonassen, 1996). Cognitive maps are unique to each learner and, since they represent a specific learner's knowledge, they must be created by the learner whose knowledge they represent. This knowledge engineering technique may be most beneficial if the learner is able to dynamically alter his/her cognitive map while in a learning situation.

Harmon (1992) theorizes that navigational strategy exhibited by a learner is related to his or her semantic network and that the navigational strategy employed by a learner is influenced by preexisting knowledge. Harmon and Dinsmore (1994) examined how learners "form semantic association[s]" in a hypermedia environment. They found that the types of associations, or links, made by learners in hypermedia closely resembled the types of links that comprise semantic networking schemes (Harmon & Dinsmore, 1994; Fisher, 1990; Lambiotte, Dansereau, Cross, & Reynolds, 1989).

The interrelationships between navigation, hypermedia, and semantic and cognitive representations may be best understood in terms of metacognition. Duell (1986) defines metacognition as knowledge about and regulation of the process of knowing. As learners struggle with choosing appropriate problem-solving strategies, planning activities, and monitoring progress toward possible solutions, soft-process evaluation can be instrumental in making these metacognitive skills more apparent and available to the learner. Suggestions can be given, guidance offered, and questions asked that will focus the learner's attention on what he/she is doing. Soft-process evaluation enhances metacognitive awareness by helping learners direct attention to how learning occurs with the ultimate aim of helping learners learn about themselves as learners.

Conclusion

Viewing POEM as a continuum, reliability and predictive validity increase as evaluation strategies move from "soft" to "hard" categories. POEM stresses an equilibrium between objective/quantifiable and subjective/qualitative evaluation approaches. The value of the model is its depiction of a holistic framework for evaluation.

Evaluation must move away from its competitive nature and toward a more humane treatment for measuring student knowledge and ability. Unfortunately, teachers-in-training get little or no formal instruction on comprehensive evaluation techniques and strategies.

Following the direction of Eisner's (1983) educational connoisseurship and educational criticism model, teachers and learners alike can benefit from embracing a critical connoisseurial outlook and understanding of evaluation and how best to measure learning experiences in meaningful ways. Becoming comfortable with these techniques takes time and practice, coupled with mutual respect between all involved in the evaluation process. Honest and open discussions with multiple evaluators where the learner is encouraged to question opinions and critically judge his/her own work will build better learners, better evaluators, and more humane and authentic learning environments.

Evaluation profoundly impacts American education. Throughout the schooling experience, learners are subjected to countless tests, quizzes, and examinations that purport to measure what has been learned. According to many educators the emphasis on tests has usurped the mission of schools to such an extent that the tests themselves control what teachers teach. Of course the problem is not this tendency to "teach to the test," but the quality and unidimensionality of the tests themselves (Wiggins, 1989).

POEM provides a framework to encourage educators and instructional designers to incorporate a variety of evaluation components within constructivist learning strategies. POEM reflects the importance of multiple evaluation strategies and proposes ways technology can be used to supplement and complement traditional evaluation efforts.

References

Berliner, D. C. (1992). Redesigning classroom activities for the future. *Educational Technology, 32* (10), 7-13.

Brandt, R. (1993). On teaching for understanding: A conversation with Howard Gardner. *Educational Leadership, 50* (7), 4-7.

Bransford, J.D., Sherwood, R.D., Hasselbring, T.S., Kinzer, C.K., & Williams, S.M. (1992). Anchored instruction: Why we need it and how technology can help. In D. Nix & R. Spiro (Eds.), *Cognition, education, and multimedia* (pp. 115-141). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18* (1), 32-42.

Carey, L. M. (1988). *Measuring and evaluating school learning*. Boston, MA: Allyn and Bacon, Inc.

Choi, J., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research & Development, 43* (2), 53-69.

Cognition and Technology Group at Vanderbilt. (1993). Anchored instruction and situated cognition revisited. *Educational Technology, 33* (3), 52-70.

Cronin, J. F. (1993). Four misconceptions about authentic learning. *Educational Leadership, 50* (7), 78-80.

Darling-Hammond, L. (1994a). Performance-based assessment and educational equity. *Harvard Educational Review, 64* (1), 5-30.

Darling-Hammond, L. (1994b). Setting standards for students: The case for authentic assessment. *The Educational Forum, 59* (1), 14-21.

Duell, O. K. (1986). Metacognitive skills. In Phye, G. D., & Andre, T. (Eds.), *Cognitive classroom learning: Understanding, thinking, and problem solving*. New York, NY: Harcourt Brace Jovanovich, Publishers.

Eisner, E. (1983). Educational connoisseurship and criticism: their form and functions in educational evaluation. In Madaus, George F., Scriven, Michael S., and Stufflebeam, Daniel L. (Eds.), *Evaluation models: Viewpoints on educational and human services evaluation* (pp.335-348). Boston, MA: Kluwer-Nijhoff Publishing.

Engel, B. S. (1994). Portfolio assessment and the new paradigm: New instruments and new places. *The Educational Forum, 59* (1), 22-27.

English, F. W. , & Hill, J. C. (1994). *Total quality education: Transforming schools into learning places.* Thousand Oaks, CA: Corwin Press, Inc.

Fisher, K. M. (1990). Semantic networking: The new kid on the block. *Journal of Research in Science Teaching, 27* (10), 1001-1018.

Flynn, I. M. (1994). *Design, development and testing of an interactive multimedia information system for classmates of young cancer patients: A case study.* Unpublished doctoral dissertation, University of Pittsburgh, Pittsburgh.

Haney, W., & Madaus, G. (1989). Searching for alternatives to standardized tests: Whys, whats, and whithers. *Phi Delta Kappan, 70*_(9), 683-687.

Harmon, S. W. (1992). *On the nature of exploratory behavior in hypermedia environments: Considerations of learner use patterns of hypermedia environments for the design of hypermedia instructional systems.* Unpublished doctoral dissertation, University of Georgia, Athens.

Harmon, S. W., & Dinsmore, S. H. (1994). Novice linking in hypermedia-based instructional systems. *Computers in the Schools, 10* (1/2), 155-170.

Harris, M., & Cady, M. (1988). The dynamic process of creating hypertext literature. *Educational Technology, 28* (11), 33-40.

Jonassen, D. H. (1988). Designing structured hypertext and structuring access to hypertext. *Educational Technology, 28* (11), 13-16.

Jonassen, D. H. (1991). Evaluating constructivistic learning. *Educational Technology, 31* (9), 28-33.

Jonassen, D. H. (1996). *Computers in the classroom: Mindtools for critical thinking.* Englewood Cliffs, NJ: Merrill.

Jonassen, D. H., Campbell, J. P., & Davidson, M. E. (1994). Learning *with* media: Restructuring the debate. *Educational Technology Research & Development, 42* (2), 31-39.

Kinzie, M. B., & Berdel, R. L. (1990). Design and use of hypermedia systems. *Educational Technology Research & Development, 38* (3), 61-68.

Kinzie, M. B., & Sullivan, H. J. (1989). Continuing motivation, learner control, and CAI. *Educational Technology Research & Development, 37*_(2), 5-14.

Krovetz, M., Casterson, D., McKowen, C., & Willis, T. (1993). Beyond show and tell. *Educational Leadership, 50* (7), 73-76.

Kumar, D. D. (1994). Hypermedia: A tool for alternative assessment? *Educational & Training Technology International, 31*_(1), 59-66.

Kumar, D. D., Helgeson, S. L., & White, A. L. (1994). Computer technology-cognitive psychology interface and science performance assessment. *Educational Technology Research & Development, 42* (4), 6-16.

Lambiotte, J. G., Dansereau, D. F., Cross, D. R., & Reynolds, S. B. (1989). Multirelational semantic maps. *Educational Psychology Review, 1*_(4), 331-367.

Laszlo, A., & Castro, K. (1995). Technology and values: interactive learning environments for future generations. *Educational Technology, 35* (2), 7-13.

Lehrer, R., Erickson, J., & Connell, T. (1994). Learning by designing hypermedia documents. *Computers in the Schools, 10* (1/2), 227-254.

Locatis, C., Letourneau, G., & Banvard, R. (1989). Hypermedia and instruction. *Educational Technology Research & Development, 37* (4), 65-77.

Marchionini, G. (1990). Evaluating hypermedia-based learning. In D. H. Jonassen and H. Mandl (Eds.), *Designing hypermedia for learning* (pp. 355-373). New York: Springer-Verlag.

Misanchuk, E. R., & Schwier, R. A. (1992). Representing interactive multimedia and hypermedia audit trails. *Journal of Educational Multimedia and Hypermedia, 1*, 355-372.

Morrison, D., & Collins, A. (1995). Epistemic fluency and constructivist learning environments. *Educational Technology, 35* (5), 39-45.

Newmann, F. M., & Wehlage, G. G. (1993). Five standards of authentic instruction. *Educational Leadership, 50* (7), 8-12.

Nickerson, R. S. (1988). Technology in education: Possible influences on context, purposes, content, and methods. In Nickerson, R. S., & Zodhiates, P. P. (Eds.), *Technology in education: Looking toward 2020* (pp. 285-317). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher, 16* (9), 13-20.

Savery, J. R., & Duffy, T. M. (1994). Problem based learning: An instructional model and its constructivist framework. *Educational Technology, 35* (5), 31-38.

Slavin, R. E. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 48* (5), 71-82.

Stepien, W., & Gallagher, S. (1993). Problem-based learning: As authentic as it gets. *Educational Leadership, 50* (7), 25-28.

Tennyson, R. D., Christensen, D. L., & Park, S. I. (1984). The Minnesota adaptive instructional system: An intelligent CBI system. *Journal of Computer-Based Instruction, 11* (1), 2-13.

Webb, N. M. (1995). Group collaboration in assessment: Multiple objectives, processes, and outcomes. *Educational Evaluation and Policy Analysis, 17* (2), 239-261.

Wiggins, G.. (1989). A true test: Toward more authentic and equitable assessment. *Phi Delta Kappan, 70* (9), 703-713.

Wiggins, G. P. (1993). *Assessing student performance: Exploring the purpose and limits of testing*. San Francisco, CA: Jossey-Bass Publishers.

Wilson, B. G. (1995). Metaphors for instruction: Why we talk about learning environments. *Educational Technology, 35* (5), 25-30.

Worthen, B. R., & Spandel, V. (1991). Putting the standardized test debate in perspective. *Educational Leadership, 48* (5), 65-69.

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