An Outcomes-Based Taxonomy for the Design, Evaluation, and Research of Instructional Systems

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Introduction

Clearly articulated learning outcomes are essential to the effective design of instructional systems. In this report we provide an expanded and clearly articulated taxonomy of learning outcomes for instructional design. Commonly used taxonomies emphasize the acquisition of intellectual skills and verbal information. We believe that engaging a greater range of learning outcomes than isolated intellectual skills is essential for meaningful learning; outcomes such as structural knowledge, situated problem solving, executive control, ampliative strategies, motivational outcomes, and self-knowledge. These outcomes need to be included in the repertoire of design models that instructional designers employ. Our expanded taxonomy of learning outcomes may be used to design or evaluate instructional systems and to generate research questions about them.

Assumptions

We undertook the development of the taxonomy of learning outcomes because we believed that learning taxonomies embedded in classical instructional design models do not adequately address important outcomes and requirements of newer, more constructivist learning environments (Duffy & Jonassen, 1992). We argue that current instructional design models (Dick & Carey, 1991; Gagné et al. 1992; Kemp, Morrison & Ross, 1993; Merrill, 1983; Smith & Ragan, 1993) do not provide a complete set of outcome-based design prescriptions because they do not:

- identify all possible learning outcomes;
- stress the self-management and self-instruction roles of the learner in the learning/instructional process (metacognition), concentrating upon direct instructional interventions;
- recommend sufficient cognitive learning (learning-to-learn) strategies for learners;
- provide micro-level instructional prescriptions (tactics) for combined learning outcomes, rather focusing on prescriptions for individual learning outcomes (concepts, rules, principles), and
- detail measurement methods and criteria for learning outcomes;

- clarify the benefits (payoffs) of acquiring each learning outcome.

Therefore, in developing the taxonomy, we made the following assumptions about its composition:

1. A taxonomy should be a comprehensive research and development system. Kyllonen and Shute (1989) indicated that the first purpose for a learning taxonomy is to provide a tool for facilitating learning task analysis and the second to focus research. We believe that taxonomies should also be used for the evaluation of instructional systems.
2. A learning outcome taxonomy should contain more than each outcome's defining characteristics. It should detail each outcome's assessment criteria and instructional methods. A taxonomy then becomes a guide for instructional development and research. Taxonomies such as those by Royer, Cisero and Carlo (1993) and Gagné (1985) have specified general assessment methods for various learning outcomes. However, previous taxonomies have not considered instructional tactics and measurement criteria in sufficient detail for them to be a research and development system.
3. New outcomes must be theoretically and pragmatically distinct from existing ones. Outcomes are distinguished from each other by three criteria: conceptual distinctions (definitions), performance criteria (measurement indicators) and payoff (effects of outcome attainment). For example, a "mental models" outcome should differ from "problem solving" in its cognitive composition (conceptual distinction), learned behavior (performance), and benefits to the learner (payoff measure). If outcomes cannot be distinguished in all three ways from each other, they are not a separate outcome.
4. Learning outcomes, while theoretically and pragmatically distinct, typically occur concurrently. Most real-world tasks require the completion of multiple outcomes in an integrated fashion (Simon, 1995). Gagné and Merrill (1990) described these outcome combinations as *enterprises*.
5. Outcome-based learning is assessed with multiple measures. Just as real world tasks engage coordinated sets of skills and knowledge (enterprises, if you will), their assessment requires multiple measures which are consistent with the skills

being assessed. For example, student learning of cockpit troubleshooting may require assessments of mental models, task persistence, and factual knowledge.

6. Current taxonomies must be reconsidered in light of recent instructional technology developments. Advances in learning theory and technology have warranted a reconsideration of the standard classifications of learning outcomes exemplified by Gagné et al. (1992) and Dick et al. (1991). New outcomes are being targeted in research, recommended in learning theory, and necessitated by technological innovations such as multimedia. In particular, there is a trend toward helping learners acquire integrated knowledge, knowledge extension skills, self-awareness and self-control. We believe these outcomes are reflected in our taxonomy.

Method

Sources and Criteria for Deriving the Taxonomy

The outcomes, measures and instructional strategies for this taxonomy are based on multiple data sources of research, theory, practice and experience. Our research process included the following activities.

1. We reviewed recognized training and design textbooks that contained taxonomies (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956; Dick et al. 1991; Gagné, 1977; Gagné et al. 1992; Goldstein 1993; Kemp et al., 1994; Seels et al., 1993). This review generated a list of traditionally recognized outcomes, strategies and measures.
2. We then reviewed current texts and articles that argued for modifications of existing learning taxonomies (Jonassen, Beissner & Yacci, 1993; Kraiger, Ford, & Salas, 1993; Kyllonen et al. 1989; Tessmer, Wilson, & Driscoll, 1990). This review generated additional candidate learning outcomes, measures and strategies.
3. We reviewed the 1991-96 editions of instructional research journals, including the American Educational Research Journal, Educational Technology: Research and Development, Journal of Educational Psychology, Performance

Improvement Quarterly, Review of Educational Research. This review generated a list of learning outcomes, measures and strategies that reflected the research community's current interests.

4. We also reviewed current educational psychology texts (e.g. Anderson, 1995, p. 41; Driscoll, 1994; Ormrod, 1995). These texts described the types of cognitive structures and outcomes posited by contemporary theories of cognitivism, constructivism, and connectionism.

The final list of outcomes was generated from these sources. Using the Goldstein (1993) and Gagné et al. (1992) taxonomies as standards for existing outcomes, additional outcomes were identified. Those outcomes (a) reflect learned behaviors absent from classic learning taxonomies, including inferencing, analogizing, assessing task difficulty, and decomposing problems; (b) reflect cognitive structures acquired in learning that were not emphasized in traditional cognitive-behavioral taxonomies, including outcomes such as structural knowledge, self-knowledge, and mental models; and (c) complement but do not duplicate the behaviors and structures of traditional learning outcomes included in the new taxonomy, including attitudes, procedures, rules, concepts, and problem solving.

Table 1 outlines some of the defining elements of each learning outcome we identified. It is meant as an introduction to our more exhaustive explanation of each outcome published in Training Research Journal (Jonassen & Tessmer, 1996/97). In Table 1, each outcome is "defined" by its outcome class, the type of measurement that affirms its attainment, and its distinct measurement criteria. To clarify our explanation of each outcome, an example is included at the end of the table. Table 2 explains the distinguishing characteristics and unique payoffs for each class of outcomes. The full text of our work on learning outcomes is published in Training Research Journal (Jonassen & Tessmer, 1996/97), which details the instructional strategies and tactics for each learning outcome.

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Table 1. Taxonomy of learning outcomes

No.	Outcome	Class	Measurement	Criteria
1.1	Cued propositional information	Declarative knowledge	Recognition	Accuracy
1.2	Propositional information	Declarative knowledge	Recall	Accuracy
1.3	Acquiring bodies of information	Declarative knowledge	Paraphrase (gist)	Thematic fidelity
2.1	Information networking	Structural knowledge (declarative)	Relationships/ Similarity judgements	Correctness/ Consistency/ Completeness
2.2	Semantic mapping/ conceptual networking	Structural knowledge (conceptual)	Concept mapping	Completeness/ Embeddedness/ Integratedness
2.3	Structural mental models	Structural knowledge	Talk backs/ Pathfinder nets	Congruence with experts
3.1	Forming concepts	Cognitive components/ structural knowledge	Identifying/classifying New instances	Generalization discrimination
3.2	Reasoning from concepts	Cognitive components	Drawing conclusions, Recognizing entailments	Logic of inclusion/inference
3.3	Using procedures	Cognitive components	Performing procedures	Accuracy/speed/automaticity
3.4	Applying rules	Cognitive components	Demonstrating algorithms/ Procedures	Accuracy/speed/automaticity
3.5	Applying principles	Cognitive components	Drawing implications (cause, conclusion, results)	Misconceptions/errors

Table 1 (Continued). Taxonomy of learning outcomes

No.	Outcome	Class	Measurement	Criteria
3.6	Complex procedures (convergent problem solving)	Cognitive components	Selecting/using cognitive comp	Effectiveness/efficiency of solution strategy
4.1	Identifying/ defining problem	Situated problem solving	Describing problem space	Absence of pre-defined solution/real problem
4.2	Decomposing problem/ Integrating cognitive components	Situated problem solving	Identifying issues/ operations/subproblems	Correct operations
4.3	Hypothesizing solutions	Situated problem solving	Generating hypotheses/ solution options	Originality/variety/efficiency
4.4	Evaluating solutions	Situated problem solving	Assessing hypotheses/ solution options	Congruence with problem space/elegance
5.1	Mental modeling	Knowledge complexes	Talk backs/teachbacks	Congruence with experts
6.1	Generating new interpretations	Ampliative skills	Stating/defending/ rationalizing	Process relevance
6.2	Constructing/ Applying arguments	Ampliative skills	Stating/defending/ rationalizing	Compellingness
6.3	Analogizing	Ampliative skills	Analogies	Correctness/plausibility
6.4	Inferencing	Ampliative skills	Inferring from knowns/ drawing implications	Reasonableness/plausibility
7.1	Articulating content (prior knowledge)	Self knowledge	Explaining/differentiating/ integrating performance	Accuracy

Table 1 (Continued). Taxonomy of learning outcomes

No.	Outcome	Class	Measurement	Criteria
7.2	Articulating sociocultural knowledge	Self knowledge	Explaining/differentiating/ integrating performance	Congruence of behavior with mores
7.3	Articulating personal strategies (strategic knowledge)	Self knowledge (metacognition)	Explaining/think aloud	Congruence with work behavior
7.4	Articulating cognitive prejudices/ weaknesses	Reflective self knowledge	Explaining/differentiating/ integrating performance	Triangulation of personal/ social feedback
8.1	Assessing task difficulty	Executive control	Problem assessment/ think aloud	Accuracy
8.2	Goal setting	Executive control	Self report/think aloud	Problem/process relevance
8.3	Allocating cognitive resources	Executive control	Self report/think aloud	Problem/process relevance
8.4	Assessing prior knowledge	Executive control	Self report/think aloud	Problem/process relevance
8.5	Assessing progress/error checking	Executive control	Self report/think aloud	Process completion/think aloud
9.1	Exerting effort	Motivation (conation)	Observation/self report	Intensity
9.2	Persisting on task (tenacity)	Motivation (conation)	Observation/self report	Time on task
9.3	Engaging intentionally (willingness)	Motivation (conation)	Observation/self report	Mindfulness
10.1	Making choices	attitude	Choice behavior/attitude scale	Personal containment

Table 2
Outcome Distinctions and Payoffs

Construct Class	Characteristics	Differences from related constructs	Learning payoffs
Ampliative skills	Uses rules of logic and imagination to draw conclusions, explain implications, imagine possibilities.	*Problem solving* is acquisition of solution method or heuristics. Ampliation is acquisition of information extension skills.	Learners can extend and integrate knowledge on their own. Can apply knowledge to novel situations.
Structural knowledge	A thematic set of propositions, images, concepts, or rules interconnected by various types of relationships.	*Declarative knowledge, concepts and rules* may involve the acquisition of individual outcomes without multiple relationships between them.	Learners can better recall and transfer acquired facts and skills. Improves troubleshooting skills. Facilitates ampliation (extension) of learning.
Self-knowledge	Uses reflection and self-examination skills to identify cognitive and affective strengths and weaknesses.	*Executive control or learning strategies* Regulation of cognitive or affective states. Self-knowledge stresses awareness of them.	Allows learner to self-correct learning and performance. Removes emotional impediments. Develops self-regulation & distributed cognition (metacognition).
Situated problem solving	Emphasizes problem solving in authentic performance contexts. Identifies the suboutcomes of problem solving (identication, decomposition, etc.)	*Complex procedures* have a definable set of steps or solutions. Situated problem solving proceeds by heuristics with multiple "correct" solutions.	Facilitates problem solving transfer to workplace contexts Enables diagnosis of specific problem solving failures.
Executive control	Focuses upon controlling internal learning and problem solving processes.	*Motivation* focuses upon control of conative and affective states during learning and problem solving, not cognitive.	Develops problem solving efficiency. Improves teamwork and social learning.
Motivation	Involves the willful manipulation of task attention. effort, and enthusiasm. Has distinct suboutcomes of willigness, persistence, and effort.	*Attitudes* are value-based and stable propensties to act or choose. Motivation has will-based and transient states of feeling or exerting.	Enhances learning and performance effectiveness in all outcome domains. Develops self-regulated learning (metacognition).