

Five Instructional Design Principles Worth Revisiting

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The work of instructional designers has changed considerably in the past decade. Gone are the days when our biggest challenges were getting enough time from subject matter experts for task analysis or building interactivity into computer-based training materials. We still have those challenges of course, but in addition we have to contend with

- increasingly complex and distributed development processes and access/delivery environments,
- designing modular learning assets that can be used and reused in different ways by different audiences,
- designing non-traditional learning spaces and systems that facilitate knowledge sharing and collaborative learning,
- designing learning and performance support materials that are embedded in work tasks and situations.

When approaching any of these design challenges it is sometimes easy to lose sight of fundamental principles that apply to all learning and all external conditions that support learning and performance. This article revisits some of those principles:

- Learning is not performance
- The medium is not the method
- Match external and internal conditions
- Authentic practice makes perfect
- One size does not fit all

By keeping these principles in mind, regardless of the context or final product, designers can be more confident that their designs are based on sound theory and research, and will maximize learning and performance.

ID Principle 1: Learning is not performance

Instructional designers design learning resources and environments that develop learners' expertise and increase their ability to perform certain tasks. However, increased competence may not translate into performance unless two conditions are met:

1. The learning resources must target competencies that contribute to exemplary performance of tasks that are critical to the accomplishment of desired levels of department or organizational performance. In other words, the learning objectives must be aligned with performance that has been explicitly identified as important, and with competencies and tasks that are related to that important performance.
2. Other factors in the performer and the work environment that influence performance must also be optimized (Gilbert 1979; Rummler, 2004); see Figure 1. For example, the learner must be motivated to apply the new

knowledge, there must be adequate incentives to apply the new skill, and the systems and work processes must necessitate and facilitate the application of the new knowledge. While not all instructional designers

Figure 1: Variables that Influence Performance (based on Gilbert, 1979)

	Information	Resources	Motivation
Environment	Data <ul style="list-style-type: none"> ▪ Expectations ▪ Information ▪ Feedback 	Instruments <ul style="list-style-type: none"> ▪ Tools ▪ Processes 	Incentives <ul style="list-style-type: none"> ▪ Rewards ▪ Recognition ▪ Consequences
Individual	Knowledge <ul style="list-style-type: none"> ▪ Declarative ▪ Procedural 	Capacity (Physical, Mental, Emotional) <ul style="list-style-type: none"> ▪ G ▪ Personality ▪ Match to job 	Motives <ul style="list-style-type: none"> ▪ Preferences ▪ Perceptions/ Beliefs ▪ Match to job

have the freedom or expertise to be performance consultants, they need to at least describe the conditions (of performers and work environments) under which the new learning will have the greatest chance of impacting performance.

ID Principle 2: The medium is not the method

Research on learning from media has led to the conclusion that any learning benefits associated with the use of a medium, such as the computer or the internet, result from instructional methods that are delivered by or accessed through the medium, and not the medium itself (Clark, 1983; Clark, 2001). Media are delivery/access technologies, while instructional methods are the “active ingredients” that influence learning and motivation. Instructional methods include ways in which information is organized and sequenced, types of practice activities, and amount and types of feedback.

Some media or combinations of media make it more feasible to implement particular methods or combinations of methods. For example, the internet makes it easier to implement flexible learning environments where information is organized in chunks which can be accessed on demand by different learners in different situations, or pushed depending on the current state of a learner’s profile. Designers should design to maximize the strengths of a medium, but should not expect that any quality of a medium will by itself influence the effectiveness of the content that is accessed through it.

ID Principle 3: Match external and internal conditions

Learning occurs in the mind; therefore, instructional methods should be compatible with the cognitive processes involved in the acquisition, storage, and

retrieval of knowledge. This presumes that we have a valid theory about those cognitive processes. Robert Gagne (1970) was one of the first to specify a set of instructional elements that would provide the external conditions to support internal processes necessary for learning. Gagne distinguished nine “events” or components of instruction:

1. Attention
2. Objective
3. Prerequisite knowledge
4. Information
5. Guidance
6. Performance (Practice)
7. Feedback on correctness
8. Performance (Assessment),
9. Support for retention and transfer

More recent models of instruction have suggested components that align more closely with the cognitive processes involved in learning. For example, cognitive apprenticeship (Collins, Brown, & Newman, 1989) distinguishes six instructional components:

1. Modeling (demonstrating how to do something)
2. Coaching (while a learner practices the task)
3. Scaffolding and fading (doing some parts of a task for a learner and gradually taking away the assistance as expertise develops)
4. Articulation (learners talking about what they are learning)
5. Reflection (learners reflecting on their learning)
6. Exploration (learners going beyond the tasks set by the designer to explore their own interests).

Internal Conditions for Learning

Although Gagne did not have the benefit of the past 30 years of cognitive research on learning, many of his events of instruction supported internal learning processes that have since been validated. If we consider the most complete and validated cognitive theory of learning that exists, John Anderson’s theory (1993, 1999), we can more precisely map external conditions to the stages of that internal learning process. Anderson’s theory proposes that we acquire two types of knowledge about any domain: declarative knowledge and procedural knowledge and that there are three stages of learning. All knowledge starts out in stage 1 as declarative knowledge, which is knowledge about concepts, principles, and procedures in a domain. The structure of an expert’s declarative knowledge is much more dense and integrated than the structure of a novice’s.

Given the opportunity to be applied, in stage 2 of the learning process, declarative knowledge gets transformed into procedural knowledge which consists of if-then condition-action rules. Procedural knowledge is generated through the application of declarative knowledge in particular situations, so that

concepts, principles and procedures get associated with cues in the external environment. Procedural knowledge has the potential to become automated through repeated practice. Automation is the third stage of learning in Anderson's theory. Automated procedural knowledge is very efficient and frees up working memory to draw on declarative knowledge when novel situations arise. If a task is novel, then success depends on the quality of one's declarative knowledge. If a task is familiar, then success and speed of solution depends on the automaticity of one's procedural knowledge.

If we adopt Anderson's model of the internal conditions that operate during learning, then as designers, we design external conditions to support the three stages of learning. The external conditions required to support each of the three stages of learning are presented in Figure 2. Accurate information is essential to the first stage; opportunities to practice and corrective feedback are essential to

Figure 2: External Conditions that Support Internal Conditions of Learning

	Stages of Learning (Anderson, 1999)		
	Declarative	Proceduralization	Automation
Learning Resources (External Conditions) that Support Each Stage	<ul style="list-style-type: none"> • Information (text, images, diagrams) • Demonstrations • Stories • Discussions • Note-taking • Q&A • Comprehension quizzes • Job aids 	<ul style="list-style-type: none"> • Authentic practice opportunities (projects, problems, scenarios, cases) • Response can be open-ended or multiple-choice • Monitoring and analysis of performance (can be human or automated) • Feedback/coaching to correct errors 	<ul style="list-style-type: none"> • Unlimited opportunities to practice • Feedback on speed and overall accuracy • Requires months and years of job performance

the second, and repeated practice of accurate procedures is essential to the third stage.

Internal Conditions for Motivation

Many learners perform poorly, not because they lack ability or because a learning activity was not designed to take them through the first two stages of learning; many learners do poorly because they are not motivated to invest the effort and persistence required to achieve particular learning goals. If, as designers, we want to maximize the impact of our learning designs, we need to understand the internal beliefs/perceptions that determine levels of motivation, so that we can design external conditions to diagnose and correct perceptions that lead to lack of effort. What makes a learner not invest effort or persist? Most reasons for lack of effort in a learning situation can be classified into three general factors (Boekaerts, 1987; Lepper et al., 1993; Salomon, 1983; Clark, 1998):

1. Low perception of value of the task.
2. Too low or too high perception of the difficulty of the task. The relationship between perceived difficulty and effort is an inverted U. Learners whose perceived difficulty of a task is very low do not invest effort; neither do learners who think that a task is very difficult. Effort is maximized when a task is perceived as moderately challenging.
3. Preferences for learning methods and media other than those provided. For example, a learner might prefer working in small groups to working alone, or might prefer reading textbooks to listening to lectures, or might prefer structured learning experiences to open learning environments.

Figure 3 summarizes the external conditions required to prevent, monitor, and treat internal motivation deficiencies with root causes in value, difficulty, or preferences. Depending on the root cause, the treatment will be different.

Figure 3: External Conditions for Motivation

Root Cause	Prevention	Monitoring and Diagnosis	Treatment
Low PV	Explain value; Stories/Role models; Rewards; Obvious transfer to job;	Scores Time Choice Effort Persistence Questions Surveys Interviews	Explain value; Role model with high PV; Monetary reward
Low PD	Estimate difficulty, effort, and time required		Suggest more effort; Stories about role models; Engineer failure
High PD	Explain strategies/support for learning in the program; Role models		Explain support; Offer more guidance; Engineer success
Preference Mismatch	Explain benefits of methods/media provided		Model appropriate preferences; Offer choice of methods/media; Change elements that don't compromise effectiveness

In order to diagnose the root case and provide the correct treatment for motivational deficiencies, the learning system must periodically gather data on learners' perceptions and preferences. The learning system can ask learners directly what they like and dislike about particular learning activities, what they find easy and difficult, and what they think would make the experience more valuable and more/less challenging for them. This perception and preference data can guide the group and individual feedback that is given to inoculate against or remediate motivation problems (which are manifested as lack of engagement, effort, and persistence). For example, if many learners indicate that they think some aspect of the content is extremely difficult, then the system can reassure learners that more examples and coaching will be provided, or that

more time will be allocated to the topic, and the system can adapt the content accordingly.

Designing external conditions that support the internal conditions necessary for both learning and motivation requires the design of flexible learning environments that gather and analyze data, and can adapt to the perceptions, preferences, and ongoing performance of the learner. When learners perform poorly on practice exercises or assessments, motivational causes should be investigated and treated or ruled out before assuming cognitive or knowledge deficiencies.

ID Principle 4: Authentic practice makes perfect

It is only through practice that people learn to use/proceduralize knowledge. Regardless of how much information (declarative knowledge) learners acquire what they will be able to do with that information on the job depends on what they have had an opportunity to do with it during instruction. Therefore, practice should match the goals of instruction, which in turn should match job task performance. Figure 4 shows what kinds of information and practice are most appropriate for the learning goals in Merrill’s (1994) content-performance matrix

Figure 4: Matching Practice to Performance

Target Knowledge	Information to Present	Practice/Assessment	
		Remember	Use
Fact	the fact	recognize or recall the fact	Recognize or recall during task performance
Concept	the definition, critical attributes, examples, non-examples	recognize, recall, or explain the definition or attributes	identify, classify, or create examples
Principle	the principle/rule, examples, analogies, stories	recognize, recall, or explain the principle	decide if principle applies; predict an event; apply the principle to solve a problem or make decisions
Procedure	list of steps, demonstration	recognize, recall, or reorder the steps	decide when to use; perform the steps
Process/System	description of stages, inputs, outputs, diagram, examples, stories	recognize, recall, explain, or reorder the stages	identify origins of problems; troubleshoot; predict events; solve problems in the process

which is the basis of most current learning object strategies. While the type of information is determined by the content type, the type of practice is determined by the level of performance being targeted.

Practice should be as authentic or realistic as possible. However, practice can be cognitively authentic (that is, can elicit the same mental processes as one uses in the real context) without being contextually authentic, that is, without taking place in the real situation (Royer, Cisero, & Carlo, 1993). For example, if the learning objective is to distinguish among different types of wounds, learners could

classify pictures of wounds, or even descriptions of wounds, rather than real wounds on real patients. If the learning objectives are principles of sales, learners could predict what will happen in a described situation, or explain why the principle operates in a described situation, or select the most appropriate solutions for problems that the principle helps solve. These activities would all be less contextually authentic than having learners actually apply the principles in real sales situations, but would give learners opportunities to deepen their declarative and procedural knowledge related to the principles.

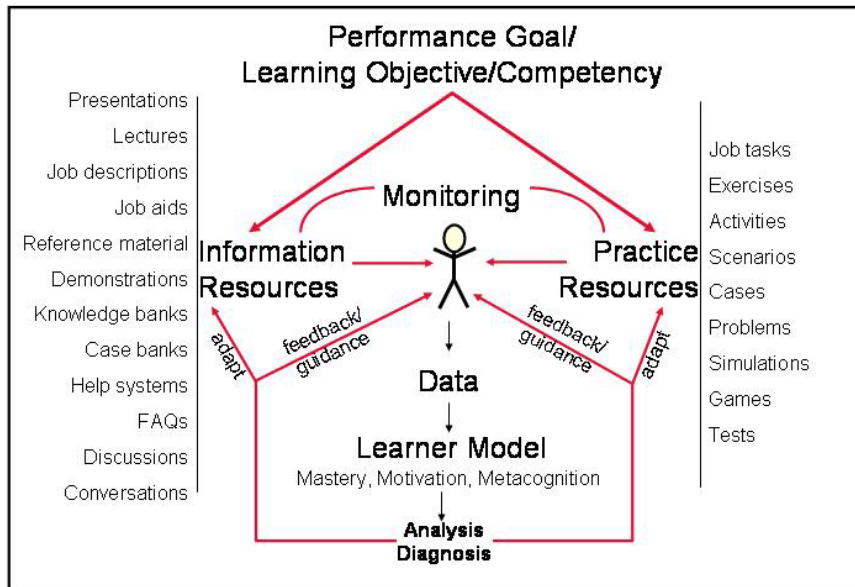
ID Principle 5: One size does not fit all

Learners are not all the same; yet we often give them all the same instructional treatment, and we wonder why they all do not do equally well. Many studies have shown that what is effective for one learner can be ineffective or even harmful for another learner. For example, Kintsch (1994) found that learners with low prior knowledge learned best from coherent text, whereas learners with high prior knowledge actually learned better with text that had coherence gaps. The gaps caused learners with high prior knowledge to process the new information more deeply, and depth of processing is positively correlated with learning and transfer (Craik and Lockhart, 1972).

The individual differences that most influence learning from instruction are prior knowledge of the domain; general cognitive ability; preferences, and perceptions of self and task (Boekaerts, 1987; Schiefele, 1991; Snow, 1994; Weinert, Helmke, & Schneider, 1989). Learners with low prior knowledge or low general ability do well with more structure, more completeness, more direction, more monitoring, and more feedback; all of these strategies reduce the cognitive load for the learner. Learners with high prior knowledge, or high general ability, do well with less structure, less completeness, less direction, less monitoring, and less feedback. Sometimes learners will prefer instruction that is not good for them; for example, learners with low general ability often choose less structured instruction when given a choice (Clark 1982). It is an instructional designer's job to design learning environments that build comprehensive learner profiles and make prescriptions that balance preferences with real cognitive needs.

There are three approaches to accommodating individual differences in instruction: 1) compensate for weaknesses (i.e., do for learners what they cannot do for themselves); 2) capitalize on strengths or preferences (e.g., if a learner prefers to learn in small groups, then let him learn in small groups as long as he is meeting learning goals); 3) remediate weaknesses (e.g., if a learner has difficulty selecting what is important, then teach her strategies for selecting what is important).

Figure 5: Dynamic Learning Environments



A learner's strengths, weaknesses, preferences and perceptions may change during the course of instruction. Therefore, accommodating individual differences involves a constant dynamic process of monitoring performance, preferences, and perceptions; diagnosing weaknesses; and adjusting feedback, information and practice activities for individuals and groups with similar profiles. This dynamic process is depicted in Figure 5. Responsibility for monitoring, feedback, and adaptation can be shared by the system, the learner, other learners and experts.

Conclusion

The more instructional designers know about the cognitive processes involved in learning and motivation, the more competent and confident they are in designing effective learning resources. An awareness of performance improvement theories and practices ensures that learning resources are not developed for the wrong reason (for example, to solve a performance problem that is not caused by a competency deficiency), and that other conditions are in place (in the individual and the environment) to maximize the impact of a learning opportunity.

Instructional designers have more control over the internal conditions of the individual than the environment in which the individual will be expected to apply newly learned skills. Therefore, designers need to build into learning environments (1) mechanisms for detecting when ideal internal conditions are not present in the individual (for example, low motivation, lack of relevant prior knowledge, or lack of cognitive ability), and (2) prescriptions for either correcting the internal deficiency or adapting the external learning conditions to better match the individual. When humans are the main facilitators of learning in a real-time setting, they can monitor learners and adapt activities on the fly.

However, only designers of intelligent tutoring systems have recognized and realized the power of continuous data collection, analysis, diagnosis, and personalization of content in an automated system. The first generation of designers who design modular learning objects for e-learning, have focused on the content of the modules rather than on the logic for personalizing or contextualizing their consumption. Designers who design learning resources for web-based delivery have an ideal opportunity to apply all that we know about learning and cognition to provide just-in-time, just-for-me learning. The principles outlined in this article can serve as a basis for doing just that.

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