The Proper Study of Instructional Design

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For almost four decades I have been associated with academic programs preparing instructional designers. During this time there have been numerous projects examining the field of instructional technology and attempting to define the "field". Each of these attempts has caused me to reflect on our activities and the students who graduate from our programs. On the 20th anniversary of the publication of Educational Technology Magazine I asked, "Can the adjective instructional modify the noun science?" (Merrill, 1980) In this paper I suggested that students of instructional design should be involved in both science and technology. Science activities involve theory development and experimental research to substantiate the theory. Technology activities involve the development of design procedures, instructional development, and evaluation (field research). I advocated a science-based approach in which the "…development of actual instructional materials should be done by the use of principle-based procedures …" that have been derived from theory that has been empirically verified via experimental research. It is my observation that my hope for a technology of instructional design grounded in empirically verified theory is still the exception rather than the rule. So after a quarter of a century I return to this theme.

Everyone is a teacher (designer) and they always will be.

In a dinner conversation with my brother-in-law, who was a nuclear physicist, I listened carefully and without interruption while he explained some complicated mathematical derivation that had to do with particles in the nucleus of an atom. After he finished I began to describe my own work in developing instructional design theory. He interrupted me to disagree with my ideas. I said, "Wait a minute, I didn't interrupt you when you were describing your theory." His response was very typical, "Yes, but everyone is a teacher."

And of course he is right. Everyone feels that they are a designer. Most of us have been in school for a good portion of our life. We have witnessed hundreds of hours of instruction good and bad. There is probably no other human professional activity shared by almost all members of civilized societies. Why shouldn't we feel that we know a good deal about teaching or designing instruction?

I work at a university. The university certainly subscribes to the proposition that everyone is a teacher. When the university hires a chemistry professor do they ask about his teaching experience, the classes he has had in pedagogy, or the training he has experienced in instructional design? Of course not! If professionals have published in their field they obviously know how to teach and design their courses.

Industry subscribes to this proposition that everyone is a designer. When a company needs someone in the training department where do we go? Usually to the folks who have knowledge about the content to be taught. Only rarely does a company seek a professionally trained instructional designer. Of course, with the rise of the internet and e-learning companies are seeking professional help in putting training on-line because their folks lack the technical skills required. But it is the technical skills they feel they need not help with instructional design.

Data shows that most of the instructional design is done by designers-by-assignment. This percentage is increasing as the number of instructional designers in key companies decreased by 27% in 2002 (ASTD 2003). Today you are an engineer but your company needs a course in their latest product, so tomorrow you are an instructional designer because you are assigned to be an instructional designer, not because you were trained as an instructional designer. You are a designer-by-assignment.

95% of all instructional design is done by designers-by-assignment.

Most of our instructional design programs in higher education, especially at the master's level, are preparing instructional designers. But if everyone is a designer, what is the unique role for these students? If companies are actually decreasing the number of instructional designers on their staffs and increasing the number of designers-by-assignment then

If everyone is an instructional designer, what is the unique role for our students?

what is the unique role for these students?

More and more application programs appear that make it easy for almost everyone to put up a web site or create e-learning. Can companies afford to hire professional designers when it is so easy for designers-by-assignment to create technology-based learning materials?

Perhaps we are in the same situation that was true of computer science a couple of decades ago. I remember being on a committee to approve every computer that was purchased on campus. Now we can go to Wal-Mart and purchase computers with many times the capability of the computers in those days. We had long discussions about computer literacy, now almost every college freshman owns their own computer and already knows how to use dozens of application programs.

Companies perceive instructional technology as those who know how to use the technology. As the technology becomes easier to use and as the number of experienced computer users increase, companies are seeing less need to hire professional instructional technologists. Computer science as a field soon realized that almost everyone would soon be able to acquire the skills necessary to use application programs. They realized that their focus needed to change from training computer users to studying computing. Computer scientists began to create tools that would allow everyone to be a more effective computer user. Computer literacy as an issue went away. The focus shifted to more and more user friendly computer applications.

Is instructional technology facing a similar situation? Do we need to acknowledge that instructional design is and will continue to be done by designers-by-assignment? Do we need to shift our focus from training instructional designers to the study of instruction? Do we need to shift our activities from the training of instructional designers to the creation of instructional design tools that allow everyone, designers-by-assignment, to be more effective designers of instruction?

Instructional systems design (ISD) is being seriously challenged as an effective technology (Gordon and Zemke, 2000). Most training is being created without using a systematic process. Many organizations do not see a need for professional instructional designers. If organizations are decreasing the number of instructional designers in their organizations and if the tools for creating e-learning are easier and easier to use then is

the primary role of instructional technology as a field to train instructional designers? Will instructional technology as a field survive if we continue to see our primary role as training instructional designers? And if training instructional designers is not our primary role what is? To use Wayne Hodgins analogy (reference) ice delivery companies saw their mission as delivering ice and even though they had sophisticated refrigeration equipment, they failed to see their mission as keeping things cold and went out of business when domestic refrigeration replaced ice boxes. What is the mission of instructional technology? If it is not training instructional designers, then what?

If you obtain a masters degree in instructional technology and go to work in the training department or business university of a large company what is your role most likely to be? It most likely won't be developing instruction. It is far more likely, because of your education, that you will be a training manager. What does a training manager do? You are likely to hire designers-by-assignment to actually develop the training products your company will use. Is learning how to develop courses sufficient to be a training manager? Will you be equipped with the management skills you will need? Will you have had experience in helping subject matter experts develop instruction themselves? Will you have tools and materials designed to assist you in training your designers-by-assignment to create the necessary training materials for your company? The answer to all of these questions, if you graduated from one of the many instructional technology masters or PhD programs in the United States, is most likely no. Your time in school concentrated on learning to design instruction. Your time on the job will most likely be spent in management and training others to design instruction.

Most college trained instructional designers become managers who train and direct the work of designers-by-assignment.

Unfortunately many instructional products currently designed for corporate America fall far short of their potential. They are inefficient and often ineffective. Many of these products just plain don't teach. Of what use is a training course that fails to help the learners acquire the desired knowledge and skills? Many of our students suffer significant frustration when they realize that the products produced by their training department, especially if they are in charge, fall far short of the quality instruction they

learned to design in school. How can you be better equipped to assist lay designers to create more effective and efficient training products? What is the proper study of instructional design?

The Proper Study of Instructional Design

Figure 1 suggests that the discipline of instructional design involves both science and technology. Science is the pursuit of understanding, technology is the creation of artifacts. The goal of science is knowledge about the physical world. Scientists are interesting in understanding and predicting. The goal of the engineer or designer is the design of useful artifacts and predicting the performance of the products they design (Vincenti, 1990).

SCIENCE		TECHNOLOGY		
RESEARCH	**THEORY**	**TOOLS**	**DEVELOPMENT**	**EVALUATION**
Experimental Research **Product or Research Review**	**Outcomes** **Concepts** **Propositions, models, theories**	**Technology-Based Tools** **Conceptual Tools**	**Instructional Products**	**Field Research**

Figure 1 The Science and Technology of Instructional Design

The science of instructional design involves both theory and research. Theory is about describing phenomena and predicting (hypotheses) consequences from given conditions. Research is applying appropriate methodology to test these predictions. Instructional design theory is about understanding what conditions are necessary for a learner to acquire specific instructional goals, specific knowledge and skill, or specific learning outcomes. Research is the method by which these predictions are empirically tested and verified. A major role for instructional technology should be the study of instruction and instructional design. Instructional design theory involves the careful specification of the instructional conditions necessary in order for a student to acquire the

desired learning outcomes. Instructional design research involves the application of empirical quantitative and qualitative research methods to test these predictions or prescriptions.

The technology of instructional design involves the use of empirically verified instructional design theory to the development of instructional products designed to enable students to efficiently and effectively acquire desired instructional outcomes. Instructional products can be, and often are, designed without sufficient consideration of the applicable verified instructional design theory. Such an approach is not a technology of instructional design but the art of instructional design. While an artistic approach sometimes results in effective and appealing instructional products it is often not possible to understand why such products are effective and too often it is not possible to replicate the success of a given product in a subsequent product.

The technology of instruction involves three distinct activities. Since most instruction is developed by designers-by-assignment, rather than technologists, it is necessary that the principles of effective and efficient instruction (instructional design theory) be captured in tools that provide intellectual leverage to designers who may not know the required instructional design theory. Most of our current tools provide this kind of leverage for the technology skills required such as computer programming, but fail to provide equivalent intellectual leverage for the required instructional design theory required. These tools too often assume that everyone is a designer and that the difficult skills to provide within the tool are technical skills such as computer programming.

Having developed the necessary design tools the remaining activities of a technology of instructional design is to demonstrate the use of these tools in designing and/or developing an instructional product. The final step is to predict the performance of this product and then test this performance in a trial with students from the target population.

The instructional scientist attempts to discover and test principles for instruction. The instructional technologist, using the principles discovered by the scientist, develops and tests conceptual tools (procedures) and technology-based tools (design systems) which can be used by instructional designers (either professional or lay) for the production of instructional products.

Theory

The central activity of any scientific approach always involves theory construction. Thus, any generalization constitutes a form of theory, and any investigation requires some level of theory construction. Instructional design theory is prescriptive theory rather than descriptive theory. That is, the theory identifies instructional conditions required for particular instructional consequences or outcomes. We say that instructional design theory is goal driven. The instructional consequences or learning outcomes constitute the goal. The theory then specifies learning conditions thought necessary for a learner to be able to acquire the learning goal in an efficient and effective manner.

It is important to distinguish learning outcomes from instructional outcomes. Learning always occurs. Human beings learn from every situation. Instructional goals are attained when the learning outcomes correspond with the specified instructional outcomes or instructional objectives.

How does instructional design theory arise? What is required to specify an instructional design theory? And why are there so many different instructional design theories?

"The cutting edge of science is reductionism, the breaking apart of nature into its natural components" (Wilson, 1998). But what are these natural components? Where do these natural components come from? All science begins with the invention of concepts, that is, the operational definition of what in the real world will be observed. How does a scientist determine what to observe? Usually by paying careful attention in a qualitative way to the phenomenon under consideration. For instructional design theory the instructional design scientist observes many instruction and teaching situations. The scientist tries to abstract from these situations those events, those conditions that seem to be present when learning of a particular kind occurs. The scientist then carefully defines the event or characteristic of the teaching situation that he believes contributes to the learning performance. The scientist then quantifies this condition using some appropriate metric as simple as present or absent or as complex as numerical amounts on a ratio scale of measurement.

The next step in science is to enter the defined concept (condition) into a proposition, an if … then statement. If a given amount of some condition is present then

their will be a corresponding improvement in the learning that occurs. This set of propositions constitutes an instructional design theory.

Often the instructional design theory is linked to an underlying learning theory. The learning theory explains why the predicted relationship may occur. It should be noted that the instructional design theory is the set of if-condition then-consequence prescriptions. The learning theory is a linking of these conditions to underlying learning constructs that explain why a given instructional proposition or set of propositions result in more efficient or effective learning.

An effective instructional design theory also specifies the relationships among the propositions of the theory so that the theory is not merely a set of conditions that stand in isolation but rather an set of interrelated principles that act together to produce the desired learning outcome or consequence.

Why are there so many different instructional design theories? The answer lies in the nature of science. Different investigators may not feel that the concepts previously defined are the right things to observe. Or they may feel that the terminology used to identify a given event or condition is not sufficiently descriptive so they use a different term. Instructional design theory is sufficiently immature that there has not yet been a general agreement on the conditions that have been found to be most useful nor has there been a general agreement on the terminology used to identify these instructional events or conditions. There have been several attempts at providing definitions of terminology in the field but to date none of these have been generally accepted by the majority of the field. Eventually, as more theory is defined and more research conducted to verify this theory, there will be a gradual coming together of the accepted terms and conditions that are thought to be important. The author has attempted to provide one such synthesis in another chapter in this volume (Merrill, In Press).

Instructional Design Research

Instructional design research is the testing of the instructional design prescriptions (if-conditions then-consequence or learning outcome) in a carefully controlled situation where the logic of the methodology allows one to attribute a given consequence to the conditions manipulated in the instruction rather than to some other causes.

Effective instructional design research also comprises two distinct activities: first, finding out what has already been done and second, conducting original investigations. It is often a challenge to find existing research investigations of a given instructional prescription because of the wide variety of vocabulary that is used in the field. One major activity of students of instructional design should be careful research. Another approach to research review is product review. A careful study of instructional products that have been evaluated can also provide useful data for the conditions or strategies involved in these products.

This short article is not the place to provide a detailed description of empirical research. Most academic programs provide several courses in statistical analysis and research design. However, there is a paucity of research conducted in instructional design. Too often instructional technologists are distracted by the plethora of new applications that constantly flood the market. Many instructional technologists find their fascination with the technology overrides their discipline in conducting carefully designed research studies. There is also disenchantment with the slow progress of empirical research. This impatience has too often led to the abandonment of careful empirical investigations. Surveys, case studies, ethnographic studies, and other qualitative approaches all have their place but are not a sufficient substitute for carefully conceived and conducted empirical investigations. Far too much of the instructional theory available has not received sufficient empirical verification. If you cannot find empirical verification for the instructional prescriptions then they deserve your careful attention and should be submitted to empirical verification.

Effective instructional design research starts with a prescription that if certain conditions (strategies) are present then certain learning outcomes will be achieved. There are many research studies that do not provide the required data and are of questionable value in the verification of instructional design theory. Several notable types of research that are unlikely to yield useful findings are technology-use surveys, media comparisons, when-to-teach e.g. synchronous vs asynchronous, and where-to-teach e.g. classroom vs e-learning vs blended.

We continue to see dissertations that conduct surveys about the use of technology. How many classrooms have computers? How many computers are in each classroom?

How many companies have e-learning? What percent of their training is e-learning vs instructor-led? The answers to these questions may be useful for management purposes but do little to verify instructional design theory or direct the creation of instructional artifacts that really teach.

Media comparisons are equally without value to answer these questions. Clark suggested that the delivery system is merely the truck but it is what on the truck that counts (Clark, 1983, 1994a, 1994b; Kozma, 1991, 1994). Choice of delivery system is a matter of economics and convenience not a matter of instructional effectiveness.

Effective instruction can be asynchronous or synchronous. It is the nature of the interaction with the materials, the type of practice provided, the kind of learner guidance and coaching available, the type of feedback provided that will contribute to effective and efficient learning far more than whether the instructor is on-line in real time. Effective instruction can be conducted in a classroom and over the internet. It is the effectiveness, the use of verified instructional theory, that will determine the effectiveness of the instruction not the environment where it is delivered. The proper study of instructional design would leave these questions of convenience to others and concentrate their research efforts on the verification of instructional theory that can be used to guide the development of effective and efficient instructional products that work.

There are a large number of instructional design theory questions that still do not have sufficient research support. The proper study of instructional design would investigate some of these questions. The two primary questions for instructional design are what-to-teach and how-to-teach? There are still unresolved questions about knowledge (subject matter content) selection. From all there is to teach what should be included and what should be excluded from the instruction? Knowledge sequence, what should be taught first? What second? Does order matter? And knowledge organization, how should the content be structured? What kinds of structure should we provide to the student to help them internally organize the new knowledge? And knowledge segmentation, what is knowledge object? How should knowledge objects be combined?

There are an equally large number of unresolved questions about how to teach. These questions involve effective demonstration for different types of learning, for whole tasks, for unstructured tasks; effective practice for different types of learning, for whole

tasks, for unstructured tasks; effective guidance during demonstration; effective coaching during application; how to effectively activate prior learning; how to integrate the learning with subsequent activities in the students real world; how to effectively use media? While we have some answers to some of these questions there remain many unresolved issues.

The proper study of instructional design would get students involved in multiple research studies on these and related issues about effective and efficient instructional conditions.

Instructional Design Tools

Designers-by-assignment seldom read the research and theory literature. Having formulated and verified effective design theory is merely an academic exercise unless this theory is transformed into tools that provide intellectual leverage. In a previous paper the author (Merrill, 1997) described several levels of ID tools including information containers, authoring systems, templates and widgets, learning-oriented tools, and adaptive learning-oriented tools. To date most of the ID tools available fall into the first three categories. Information containers merely enable the presentation of information and media but usually enable only the most rudimentary of instructional functions. Unfortunately most authoring systems have concentrated on making programming skills easier but have failed to provide sufficient support for important instructional design decisions. The inclusion of templates, widgets and other preprogrammed instructional algorithms are structure-oriented rather than learning-oriented, that is, the focus is on how the interaction works not on what learning outcome the interaction enables.

What are needed are learning-oriented tools, tools that have built-in instructional strategies that are based on scientifically verified principles of instruction. Tools that enable designers-by-assignment to not only easily use the technology but that provide them with extensive guidance in effective instructional design or provide them with verified, effective, predesigned instructional strategies.

Who should do what in the proper study of instructional design?

Designers-by-Assignment

How would the availability of learning-oriented instructional design tools facilitate the work of the designer-by-assignment? How would their role differ? We suggest that rather than a haphazard or artistic approach the effectiveness of the resulting instructional products would be dramatically improved if these folks were provided and taught to use learning-oriented design tools. These tools should also provide guidance, templates, and pre-built strategies that would allow comparison of existing products, data assessing usability, and most important data assessing student learning and performance. The training role of our graduates would be to provide training in the use of these learning-oriented tools and to monitor and quality control the resulting products.

Master's Degree Students in Instructional Design

For starters, we should significantly increase the amount of project management provided to our master's degree students in instructional technology. In addition, they should still learn to use existing theory and research to design instruction. But the emphasis should shift from our students as designers to our students as trainers of designers-by-assignment. As learning-oriented instructional design tools become available they should have experience first in using these tools but more importantly in helping novice designers to use these tools. The emphasis for our students should move to a detailed study of empirically verified theory and a challenge to develop technology-based or conceptual learning-oriented ID tools that they can use to help train everyone-designers they will encounter in their organizations.

PhD and Specialist Students in Instructional Design

What constitutes a proper dissertation or project? In our institution too many projects consist of a single empirical study or survey. Is this an adequate scholarly contribution for a doctorate in instructional design? I suggest that a proper dissertation would consist of all five of the parts identified in this paper. A PhD student should first identify, modify, or develop instructional design theory. The student should then do extensive product and research literature review related to the theory. In addition the student should conduct additional original empirical research related to their theory

development. But, is this adequate for a dissertation in our area? I would suggest that the student should go further. They should then develop a tool that implements the theory in a technology-based or conceptual learning-oriented instructional design tool designed for designers-by-assignment. The student should demonstrate the use of this tool for the design of instruction preferably by training a novice to use the tool. Finally the student should evaluate or supervise the evaluation of the instructional product developed by the use of the tool in a field setting. The dissertation would consist of a collection of reports: A theory paper, a product/research review paper, a report of one or more original empirical investigations, a technology-based or conceptual tool together with a user's manual, an instructional product developed using the tool, and an evaluation report of the effectiveness of the instructional product in a real-world setting.

Conclusion

Will instructional design as a field survive or will design continue to become so commonplace that everyone feels that there is no special skill required? Can we increase the quantity and quality of our empirically verified theory development? Can we develop empirically-based, learning-oriented, instructional design tools that will significantly improve the quality of the instructional products developed by designers-by-assignment? Can we transform our master's degrees from the training of instructional designers to the training of instructional design trainers and managers? What will happen if we fail to rise to this challenge? If we don't will instructional design still be recognized as a field of study in the year 2025?

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