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Dissertation Proposal

Learning Objects: A User-centered Design Process

Rovy F. Branon III

Instructional Systems Technology

Indiana University

Chapter 1: Overview of ISD Process and Learning Objects

Effective utilization of instructional systems design (ISD) process has been the subject of numerous models, articles, and books for more than 50 years. Authors of each model attempt to fill gaps left by other authors or provide guidance to instructional designers in specific contexts. All of these attempts could fill an entire bookcase or even a small library. Criticism of various models and of the model-building process itself could fill another bookcase. Yet the need for research into methods and models for effective and efficient development is becoming increasingly important as the number and sophistication of potential instructional interventions increases.

ISD Process

The term "ISD process " is used in this dissertation proposal to represent the entire process creating instruction. Gustafson and Branch (2002) use the term "instructional development (ID)" and state that it includes all of the generic steps of the ADDIE model (analysis, design, development, implementation, evaluation). Seels and Richey (1994) have called this instructional systems design (ISD), and the term "instructional design" is also commonly used to represent all of these activities. Reigeluth (2003) argues that "ISD process" is the least ambiguous term because "design" and "development" are also parts of the process. The reader should therefore assume that the use of ID or ISD in this dissertation is synonymous with "ISD process" and refers to the 1977 AECT definition of the term "instructional development:"

> A systematic approach to the design, production, evaluation, and utilization of complete systems of instruction, including all appropriate components and a management pattern for using them; instructional development is larger than instructional product development, which is concerned with only isolated products, and is larger than instructional design, which is concerned with only one phase of instructional development. (p. 172)

Benefits and challenges of ISD

One benefit of using an ISD process is that it allows scalability. The ability to mass-produce instruction has its roots in the efforts to quickly train thousands of troops during World War I and World War II (Schrock, 1995). ISD process models enhance scalability by realizing efficiencies and increased speed of development when the correct model is applied in the appropriate context (Gustafson & Branch, 2002). Additionally, a systematic approach provides the ability to continuously improve product and process through formative and summative evaluation (McCombs, 1986).

Despite the potential benefits, numerous challenges exist in fully realizing the value ISD process models can provide. Gordon and Zemke's (2000) article describes recent criticisms of the ISD process. According to that article, ISD is seen as too slow, unresponsive to the needs of the learner, based on the wrong world view, and largely ineffective. A follow up article by Zemke and Rossett (2002) acknowledged the criticisms but provided some balance to the discussion by placing the blame on inexperienced designers who adhere too rigidly to a process. They also echo McCombs (1986) by saying that there are too few skilled practitioners who understand how to effectively implement an ISD process.

Reigeluth and Nelson (1997) state that challenges to ISD are a result of the paradigm shift occurring in the larger societal system away from standardization and toward personalization. They note that developing more personalized instruction requires changes to the typical linear approach to ISD. Some of these changes might be enabled by technology that allows for the personalization of instruction or by shifting to users as designers. The realities of current practice and the limitations of technology, however, indicate a need for an ISD process that takes advantage of current knowledge and provides a bridge to a future state.

Building such a bridge means discovering ways to facilitate change among those doing the work. Including users earlier in the design process, for example, can result in more rapid creation of an instructional product (Jones & Richey, 2000). Most ISD models, however, are still focused on mass production of a single unit of instruction to meet the needs of a large audience. Personalization, or tailoring instruction to meet the needs of each individual is a major challenge facing traditional ISD.

While there are many issues with the ability of computers to personalize instruction (cf. Frick, 1997), simply having content to support a virtually unlimited number of learners is a pragmatic issue that must be solved. One solution forwarded to address scalability of personalized instruction is the use of what has commonly become known as "learning objects" (Hodgins, 2000). It is possible that building instruction using an object-based approach could help address both scalability and personalization for ISD process. The first process models are just now beginning to emerge (e.g. Barritt & Alderman, 2004) and it is an area in need of research.

Learning Objects

There are many closely related terms used to describe an object-based approach to instructional design. Merrill (1999) uses the term "knowledge object" in his Instructional Transaction Theory (ITT) to describe a component-based approach to instruction. The Advanced Distributed Learning (ADL) initiative chose to adopt the term "Shareable Content Object" (SCO) to describe the smallest component of instruction tracked by a learning management system (*ADL*, 2004). A term with wide penetration in the business community is reusable learning object or, RLO. In one white paper, Cisco (*RLO Strategy*, 2003) defines an ideal reusable learning object as "based on a single learning or performance objective, built from a collection of static or interactive content and instructional practice activities" (p. 6). Additionally, the Cisco definition states that a learning object is identified through metadata, contains raw media assets, practice, and assessment activities. The fact that there are numerous terms definitions coming from business, academia, government, and standards organizations makes clarity difficult but it signals a growing trend toward the adoption of various object-oriented approaches for e-learning.

The most comprehensive definition comes from the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE). The recently approved Learning Object Metadata (LOM) standard (*LOM*, 2002) contains the following definition of a learning object: "For this Standard, a learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training" (p. 6). Wiley (2000b) criticizes this definition as overly broad and notes that the number of definitions that surround the topic lead to a great deal of confusion. This dissertation will adopt Wiley's narrower definition and use the term "learning object" as: "any digital resource that can be used to support learning" (p. 23). Given the subtleties and variations among definitions, I will also group these similar terms under a broader umbrella of "object-based" approaches to instruction.

Benefits of an object-based approach

While the ADL (*SCORM*, 2002) sites a number of "ilities" (sharability, interoperability, durability, affordability, etc.) as reasons for using learning objects, it is reusability that is touted as having the biggest potential for changing the nature of instructional design. Reusability enables possibilities beyond simply creating two versions of similar learning content. For example, there is now less distinction between instruction and performance support (Rossett, 1996). Small chunks of instructional content can be embedded in other systems, such as customer support databases or enterprise resource planning systems (Alexander, 2002). Such reuse is one small example of how instruction is moving toward the ultimate goal of personalization by providing contextualized support to an individual just when it is needed (*S3 Report*, 2003).

ISD process for learning objects

An early metaphor used to describe use of learning objects was a comparison to the popular children's building blocks called LEGOs (Wiley, 1999). Early versions of LEGOs were largely generic allowing any block to connect to any other block of the same size. Learning objects were going to be the LEGOs of instructional design. Such objects would be reusable in nearly any course, as long as the objects were built to the same standards.

The LEGO analogy quickly breaks down because the contextualized nature of instruction defies a simple building-block approach (Wiley, 1999). While any analogy will break when pushed too far, one recent analogy that holds greater fidelity is of the building industry (*S3 Report*, 2003). According to this metaphor, learning objects are like the pre-manufactured components used in constructing 90% of the buildings created today. For example, a door does not have to be measured and created by hand for every building. A builder can create a standard frame for a door and the can owner choose from hundreds or even thousands of doors that will fit into the standard size doorframe. The same is true for windows, electrical outlets, etc. The house can still be personalized but the economies of scale make such personalization possible for the average homeowner.

Efforts are underway to enable a similar standardized approach to instructional design (*S3 Report*, 2003). Building courses or other learning environments from "prefabricated" components, however, requires a number of systemic hard technology and process technology issues to be solved. These issues include having common standards (*SCORM*, 2002), hardware (repositories, networks, etc.), business process, and ISD process. Analogous changes to the building industry did not occur overnight. It took many decades to have the infrastructure in place to ensure that the components necessary for construction were readily available at every local home improvement store. Additionally, architects had to change the way they thought about design to facilitate the use of the pre-manufactured elements. Instructional designers are in comparatively early stages of determining how a similar paradigm shift will change ISD.

Addressing all the issues related to an object-oriented approach to ISD is beyond the scope of a single dissertation. Work by Wiley (2000b; 2002), Merrill (1983; 1999), has provided significant insight into use of instructional theory for object-oriented instructional approaches. The intended contribution of this dissertation on the emerging area of learning objects is developmental research to improve ISD process.

Developmental Research for ISD Process

In the fourth edition of their survey of ISD models, Gustafson and Branch (2002) sum up the state of research:

> There is a disturbingly small volume of literature describing any testing of the models. While no one can be certain, it appears many have never actually been applied, never mind rigorously evaluated…We hope that in the future at least some ID models will be subjected to more rigorous validation. Such validation would require precise description of elements of the model, followed by systematic data collection concerning their application and the impact of the resulting instruction. The investigator would need to be alert to possible discrepant or negative data. Repeated trials under such conditions, if the model had validity, result in a set of specifications regarding the conditions under which the model was valid. It is safe to say none of the models currently available in the literature has been subjected to such rigorous scrutiny. (P. 63-64)

Lack of quality research surrounding the ISD process is not a new complaint (cf. McCombs, 1986). Gustafson and Branch (2002) note that the most popular models gain acceptance through repeated use and rarely through rigorous assessment. Studying ISD process is difficult because it is a messy endeavor and the number of potential variables is so high. Such difficulty, however, does not preclude the need for disciplined inquiry to improve practice.

Developmental research is intended to solve context-specific problems faced by practitioners, including research to develop new ISD models or validate existing ones (Richey & Nelson, 1996). Reeves (2000) describes developmental research as a "socially responsible" and calls for more studies that address real-world problems. He states that, "The overall goal of developmental research is to solve real problems while at the same time constructing design principles that can inform future decisions. (p. 27)" A problem deemed suitable for developmental research should be one that is relevant, reflects realistic situations and conditions, and relates to new technology (Richey, Klein, & Wayne, 2003). The high interest in learning objects and the shifting paradigm of ISD lends credibility to the need for new research. This dissertation will attempt to heed Reeves' call by working collaboratively with practitioners to solve a real-world problem and advance the knowledge of the field.

Goals of the Study

The goals of this study are to advance understanding of ISD process by developing a tentative ISD process model that is 1) user-centered, 2) maximizes reusability using a learning object approach, and 3) is grounded in practice. The secondary goals of the study, which will address how the study will be accomplished include:

- Identify literature that describes use of learning objects and ISD models.
- Identify grounded principles of development crucial to a user-centered ISD model for learning objects.
- Identify factors critical to the success or failure of the model.

How these goals are going to be addressed

The goals of the study will be addressed by using formative methodology to iteratively develop a model based on work by instructional design teams. The literature review focuses on three areas crucial to developing such a model: existing ISD models, research on instructional design theory for learning objects, and development of ISD process. Topics, such as infrastructure, technology, and the economics related to learning objects will be beyond the scope of this dissertation.

Overview of the chapters

The first three chapters of the dissertation are included in this proposal. Chapter 1 includes an introduction, statement of the problem, and rationale. Chapter 2 is a review of the theoretical and applied literature relevant to the topic. Chapter 3 describes the formative methodology that will be employed to develop and refine the model.

In the final study, the following chapters will be added to complete the dissertation. Chapter 4 will describe the results of the initial designed case and explain the implications for the model. The initial model will be described and depicted based on this designed case. Chapter 5 will describe the implementation of the second designed case and discuss implications for context and use of the model. Changes to the proposed model based on this second case will be included and explained. Chapter 6 will provide a discussion of the tentative model, its potential use in the field, limitations of the study, and directions for future research.

Chapter 2: Literature Review

This chapter in the dissertation proposal provides a brief background of ISD process models and describes several current models that provide input into this effort. For the models reviewed, the emphasis is on describing the principle elements that each contributes to the process being developed in this dissertation, rather than literature related to each model. The second section of the literature review gives an overview of instructional design theory that has been developed for learning objects. The third section provides a rationale for the methodology by discussing the purpose and construction of ISD process models.

ISD Process Models

ISD process models have existed since at least the 1960's (Reiser, 2001). During the 1970's, the number of models grew dramatically. These models served as the basis for many large organizations and the military to provide consistency throughout huge numbers of training development projects. By 1980, more than 40 models had been published and many more had been developed (Andrews & Goodson, 1980). Despite the large number of models, Andrews and Goodson note that there are general underlying principles that are components of most models. Some of these principles include: needs analysis, goal-setting and instructional strategy specification, development, and ongoing formative and summative evaluations. McCombs (1986) states that regardless of specific steps in a particular ISD model, "The point is, however, that ISD represents a generalized and logical flow of steps in a systematic problem-solving process that has broad application in the worlds of education and training" p.69.

Andrews and Goodson (1980) conducted one of the first comprehensive comparative analyses of ISD models. They found that the underpinnings and origins of the models varied widely. Some were theoretically based in either learning or general systems theory (or both) and others were more empirically based on the experience of instructional designers. Few of the models reviewed in that 1980 study, however, utilized both theoretical and empirical approaches in the way they were created. The intent of the models also differed. 40% models were to be used as instructional design teaching tools, 90% were for the development of instructional products, while 10% were intended to primarily help cut costs. When the authors of the models had identified a specific purpose, the data (if any was given) was generally inadequate to provide any indication of effectiveness. Only seven of the 40 models studied had enough documentation to implement as the author intended. Even these seven, however, did not contain enough information to pass judgment about the settings and conditions that might impact usage. Twenty-two years after Andrews and Goodson's comparative analysis, Gustafson and Branch (2002) still claim there is a lack of solid evidence to support many of the ISD models that exist.

Despite the lack of data, use and proliferation of ISD process models has continued. Gustafson and Branch's (2002) 4th edition of a *Survey of Instructional Development Models* details 15 of the models they consider to have had the biggest impact on the field. One useful feature of the survey is a taxonomy of ISD models. I will use this taxonomy to focus the literature review on the models most relevant for this dissertation.

The asterisks in Figure 1 signify the characteristics of the process to be developed in this study. One goal of this study is a process to facilitate development of highly distributed electronic instruction. While the focus is on creating whole courses, the desire is for the courses to be made up of smaller, reusable chunks of content. The more sophisticated nature of delivery means that the individual or team will likely have a high degree of technical skill. This research will be conducted in an environment where the emphasis is on production. Having a production-oriented focus means that the level of analysis will focus on content and implementation issues, rather than on larger organizational questions.

According to the Gustafson and Branch (2002) taxonomy, this ISD model would fall across two categories. While primarily focused on a "product orientation" some elements of the process would likely be considered within the "system orientation" classification. Models from each of these domains are explored in the following sections.

Dick, Carey, and Carey

My first exposure to ISD process models was in my master's degree program by reading Dick and Carey's (1996) *The Systematic Design of Instruction*. Originally outlined in 1978, this ISD process model has become one of the core components taught in many instructional design programs. More recently, the Fifth Edition has added James Carey as an author so, it should now be recognized as the Dick, Carey, and Carey model (2001). The logical sequence, step-by-step instructions, and comprehensiveness of the explanations have made it the most often cited ISD process model in the literature (Gustafson & Branch, 2002).

The Dick, Carey, and Carey (2001) model contains variations of all of the major components of the ADDIE process (see Figure 2) and, according to Gustafson and Branch (2002), falls into the systems orientation. Two types of analyses are conducted to assess needs, determine learner characteristics, and define broad goals. These goals are refined into specific instructional objectives while gaining an understanding of the learners and their contexts. Based on the analysis, performance objectives are specified and assessment instruments are created. An instructional strategy is selected or developed to enable learners to successfully complete the assessment and then select or develop the appropriate materials. A formative evaluation is conducted before the materials are implemented and revisions are made at the appropriate point in the process. Finally, a summative evaluation is conducted after implementation to determine the success or failure of the instruction, primarily for the purpose of making decisions about adoption or continued use of the instruction (Dick et al., 2001).

The brief description here and the graphic of the model are somewhat deceptive in their simplicity. One or more extensive chapters in a detailed book cover each step. The visual simplicity of the Dick et al. (2001) model is a benefit because novices can quickly discern the nature of the activities they will need to engage in and the order in which they should be performed. The actual work conducted within each step, however, is quite complex and is intended to be conducted by a highly-skilled designer or design team (Gustafson & Branch, 2002).

Another issue with using this model is the time it takes to conduct all of the steps in the process. Feedback from formative evaluation does not occur until relatively late in the development cycle. Even Dick and Carey (1996) note that designers should, "Be prepared to obtain information that indicates that your materials are not as effective as you thought they would be after going through such an extensive instructional design process" (p. 276). If the costs of failure are high, discovering significant issues with the instruction in the second to last step before implementation (or even during implementation), can be expensive and can threaten tight timelines and possibly the career of a designer.

Value to the development of this model: The model being developed in this dissertation seeks a similar parsimonious approach to the depiction of the activities required to develop learning objects. It is also important in a business environment to have clear, progressive steps to the end goal of a completed instructional product. Even though the model being developed in this dissertation is more product-focused (meaning a lower emphasis on analysis), the two separate analysis tasks in the Dick, et al. model will be evident.

Seels and Glasgow

The Seels and Glasgow (1998) model is more product focused than the Dick, et al. model, however, numerous similarities exist. Like Dick, et al. all of the ADDIE steps are present. There is also a somewhat linear progression of steps to produce a discernible product. The model is, however, more iterative and includes feedback and interaction with users throughout the process. This emphasis on more continual interaction guides the process as it moves through the major steps in the ISD process.

Seels and Glasgow (1998) break the linear process into three distinct phases: Needs analysis, instructional design, and implementation and evaluation (see Figure 3). They note that while each of the three major phases are linear; the activities within each phase may not be carried out in a linear fashion. This recognition that many ISD activities do not follow a linear progression helps to counter some of the criticism of ISD models (cf. Gordon & Zemke, 2000).

The Seels and Glasgow (1998) model is vulnerable to other criticism that has been levied against traditional ISD (cf. Duffy & Cunningham, 1996; Gordon & Zemke, 2000), as too deterministic for learners and designers. The resulting instruction, while perhaps demonstrating an ability to meet the objectives for the majority of learners, is still relatively inflexible when trying to meet the needs of a particular individual. It is this inflexibility in ISD that led Reigeluth and Nelson's (1997) call for a new paradigm that includes users as designers of their own instruction and utilize technology to bring increased personalization to the individual learner.

Value to the development of this model: Seels and Glasgow's (1990) recognition that development activities can be seen as both linear and iterative within the same process is important in a business context. The ability to provide guidance from a timeline and project management standpoint will be incorporated into this model.

Dorsey, Goodrum, &Schwen

Moving toward more involvement by users earlier in the ISD process, Dorsey, Goodrum, and Schwen (1997) offer a more radical departure from the previous models. Building on work by Tessmer (1994) and Tripp and Bichelmeyer (1990), Dorsey et al. outline what they call "rapid collaborative prototyping." The key to this approach is a series of quick successive steps of conceptualization, prototype development, and user-testing/feedback (see Figure 4).

Prototypes are developed very quickly in low fidelity (usually paper) formats and are shown to end-users. Rather than just getting feedback to improve the process, one of the goals is to get the end-users to provide alternative solutions to the ones proposed by the designers (Dorsey et al., 1997). Using this methodology, the users are actively involved in designing their own instruction and the designer acts as a facilitator in the process.

Rapid collaborative prototyping addresses some of the challenges to the current paradigm of ISD by placing the end-user at the center of the process. This means that rather than a designer imposing his or her world view on the learner, "instructional designs are part of a larger, real-world social system where people use designs for their own purposes" (Dorsey et al., 1997) p. 21. The potential for reduced cycle time is another positive aspect of this model that now has supporting evidence (Jones & Richey, 2000).

One concern for designers using this model is that it provides general principles, rather than specific guidance (Gustafson & Branch, 2002). Unlike the detailed descriptions by Dick, et al. (2001) or Seels and Glasgow (1998), the rapid collaborative prototyping model utilizes a more minimalist approach. Developmental research around rapid collaborative prototyping, however, is beginning to provide practitioners with additional knowledge that could enable more specific guidance to emerge. Jones and Richey (2000) describe how rapid prototyping was used in a natural work setting. Despite the fact that Jones and Richey compare two different types of ISD projects, it provides evidence that rapid prototyping contrasts favorably to a more linear ISD approach. The study also provides additional details necessary for implementation of a rapid collaborative prototyping approach such as the roles required, key phases (adding some structure without imposing linearity), and opportunities for concurrent processing (where tasks overlap). The authors note a continuing need for research to explore use of rapid prototyping in other settings.

Value to the development of this model: One of the stated goals of this dissertation is a user-centered design and development process. Of the models reviewed, the Dorsey, Goodrum, and Schwen's (1997) is the most progressive in terms of placing users at the center of the design process. While the Jones and Richey (2000) study gave evidence that designing a unique instructional solution can be done faster with rapid prototyping in one setting, it is not clear whether this is the most efficient means of ISD when large numbers of similar courses need to be created. This effort will include a similar approach to the roles on the design team while retaining some of the more traditional elements required for a scalable production process.

Frick and Boling

Frick and Boling (2002) have been formatively developing an ISD model for web-based instruction (WBI). Their model takes principles of user-centered design and combines them with more traditional principles of instructional design. The result is a model with clear guidance for ISD process and a focus on the end user of the instruction. This unpublished manuscript is one of the first models to adequately describe both the need to rapidly prototype web-based instruction with users and stakeholders, and to gather data to determine whether the product supports the intended instructional outcomes.

One of the most important aspects of the Frick and Boling (2002) process is its reliance on data to drive the design solutions (see Figure 5). The data can come from a variety of sources including usability testing and authentic assessments. Using an empirical approach helps to ensure that the product is as user-friendly as possible and that it meets the instructional objectives. This model provides enough of a linear flow to demonstrate a progression toward building a complete product while maintaining significant iterative development in the early stages of the process.

The Frick and Boling model has not yet been published outside of Indiana University so; it has not had widespread distribution. There have been, however, nine projects supervised by the authors that have successfully utilized the model (Theodore Frick, personal communication, March 22, 2004). Most of these projects contained instruction related to higher education. Some of the publicly available web-based instructional prototypes include: How to Recognize Plagiarism (http://www.indiana.edu/%7Eistd/overview.html), PHP Basics for R547 (http://www.indiana.edu/%7Eistdept/R547/PHPbasics/index.html), and a training course called RecNet Purchase Request System (http://www.indiana.edu/%7Eistdept/R547/purchase/recnet/home.html) to teach the proper use of a purchasing system to university employees.

Each of these web-based instructional units was developed for a unique purpose to meet the needs of a particular audience. A course built with this model is for use within a limited context and is typically delivered by a web server. Businesses, however, are increasingly looking for instruction that can be chunked into smaller pieces and delivered to different audiences in different contexts with little, if any additional design and development work. The content chunks can be built by hand or assembled automatically by a Learning Management (LMS) or Learning Content Management System (LCMS). There will continue to be significant demand for WBI for the foreseeable future and, while the model developed by Frick and Boling (2002) provides guidance for such courses, some differences must be considered for a more object-oriented approach.

Value to the development of this model: Similar to Frick and Boling (2002), the model in this dissertation will seek to contain clear guidance about the steps in the process while maintaining early iterative user-input. The combination of usability testing and formative evaluation of the objectives is another component that will heavily influence the guidance provided. One of the aspects not specifically addressed by Frick and Boling is the possibility of reuse and more advanced LMS or LCMS technology on the delivery of web-based instruction.

Barritt and Alderman's RLO ID Model

Barritt and Alderman (2004) have modified the ADDIE model to create an ID process for designing and developing learning objects (see Figure 6). The modifications include changing 'design' to 'design and mine,' develop evolved to 'develop, repurpose, and reuse,' and implementation is 'deliver and access.' An additional retirement step is added at the end to enable a complete RLO lifecycle.

The Barritt and Alderman (2004) book is a strategic guide for the use of learning objects. It outlines key technical and instructional issues that must be taken into account before implementation. For example, when conducting an audience analysis, it is important to remember that components of the instruction could be reused for other groups other than the original audience. According to Barritt and Alderman, major difference is that it becomes important to look for existing objects to mine, rather than designing and developing the entire course from scratch. Another consideration is that evaluation becomes more complex when the specific objective that was the subject of the initial development might not be relevant when reusing the instruction for different audiences.

Value to the development of this model: The primary value of elements from the Barritt and Alderman model that will influence the guidance provided for this dissertation are the practical and technical considerations for utilizing learning objects. Specifically, direction provided to understand the impact of reusability on an instructional design effort will be incorporated into this model. Additionally, use of metadata and other technical elements for successful creation of learning objects will also be included.

Instructional Design Theory for Learning Objects

Wiley (2002) notes that recent work regarding learning objects has focused on advancing the technology, often at the expense of instructional soundness. While such technical work is a necessary condition to enable success, it is not sufficient. Some of these basic technological specifications (e.g. the SCORM 2004) are stabilizing and gaining traction among learning software and hardware providers and many organizations are now turning toward implementation of learning objects at a design and development level. There has been work by Merrill(1983; 1999) and Wiley (2000a) regarding instructional design theory and understanding these works is important for the development of ISD process for learning objects.

Merrill's CDT and ITT theories

Merrill is a pioneer in the area of object-oriented instruction. Component Display Theory (CDT) focuses on differing presentation forms and the implications these have for structuring instruction for different outcomes (Merrill, 1983). Three major aspects to CDT are: categories for content, categories for performance objectives, and a presentation taxonomy. In later work, Merrill acknowledged that the CDT did not offer enough precision to be useful for automated instructional design systems (Merrill, 1999).

Instructional Transaction Theory (ITT) emerged from the early work with CDT to begin to address the need for more specific guidance for automated instructional systems (Merrill, 1999). Merrill used the term "knowledge objects" to represent frameworks for different types of related ways of representing subject matter. The concept of a knowledge object differs somewhat from what is currently called a "learning object," which tends to imply a piece of content, rather than a type of knowledge representation.

One goal of Merrill's ITT is to reduce the amount of labor required to create interactive computer-based instruction (Merrill, 1999). By providing an "instructional transaction shell," knowledge objects can be presented in various ways to an individual student. Merrill argues that once multiple transactions are built into a development tool, automated, adaptive instruction utilizing knowledge objects is possible. While Merrill and his colleagues in the ID_2 research group have delivered several tools to allow more automated design (Merrill, 1997; Merrill & Team, 1998), this level of technology is not currently available to most designers.

As a bridge to future practice, this research seeks to utilize some of the concepts Merrill has implemented in a more constrained technological environment. For example, Merrill (1999) defines an instructional transaction shell as, "A computer program that encapsulates the conditions for a given type of knowledge" (p. 245). Given the current use of web-based technology in many LCMSs, the best most instructional designers can currently create are templates. Merrill (1997) notes that major disadvantage of using templates is that they tend to focus on structural aspects of the platform and not learning. One component of the process being developed in this dissertation will be what I am calling "device-specific instructional templates." These templates should take into account both the structural requirements of the intended delivery device (laptop, PDA, etc.) and the intended instructional strategy. These templates would exist at the course level, serving to organize a number of learning objects into a meaningful instructional experience. Similar to Merrill's (1999) intent with instructional transaction shells, a goal of this dissertation is to reduce the amount of time required for development. While fully automated conversion from one template to another is not currently possible for most LCMSs, the approach taken in this dissertation should make it easier move to such a system as the functionality becomes available. The approach is less automated and could be called more of a by-hand approach to development with learning objects (cf. Wiley, Recker, & Walker, 2000).

Wiley's Learning Object Design and Sequencing Theory

The specific nature of Merrill's ITT theory can limit the usefulness of his knowledge object taxonomy in other instructional theories (Wiley, 2000a). The need to incorporate the growing possibilities of digital content types within meaningful instructional templates requires a broader framework. Wiley's (2000b) Learning Object Design and Sequencing (LODAS) theory provides a taxonomy for understanding how different types of learning objects can be used with a variety of instructional design theories. LODAS is primarily a design theory for complex cognitive problem-solving but Wiley notes that aspects of the theory are compatible with other types of instruction. The cornerstone of LODAS is a taxonomy for learning objects. The taxonomy shown in Figure 7 describes the properties for five different learning object types.

By outlining types of learning objects, Wiley's (2000b) taxonomy makes a consistent approach possible. The taxonomy also frames learning objects within potential instructional uses, rather than by physical properties alone. Additionally, Wiley provides guidance on connecting his taxonomy to several existing instructional design theories to give guidance on which type of object is most appropriate in a given instructional context.

Similar to Merrill's ITT, Wiley's LODAS theory has implications for ISD because it provides guidance to a designer on how to utilize different learning objects to support given outcomes. As an instructional design *theory*, however, it is not intended to provide specific guidance for the entire ISD process. LODAS provides the input to the design phase of an ISD process. This dissertation will compliment the work related to instructional design theory with a grounded approach to ISD process for learning object use.

Developing ISD Process

It is important to distinguish the creation of a process from the building of a model to represent that process. In a great deal of the ISD literature, process and model are used synonymously. In reality, any human process is dynamic and its fluidity makes modeling difficult. The problem with separating process development from model development is that once any series of activities is codified in text or visual diagram, it represents a descriptive or prescriptive abstraction of the actual activities. Therefore, I am not sure it is possible to describe a process without creating some form of model. The tentative process created by the research in this dissertation is intended to be dynamic, however, I anticipate the use of visual and textual models to relate these activities to others.

Perceptions of models guide how they are used and built. Andrews and Goodson (1980) state that models provide a representation of a phenomenon. The fidelity of the representation is a critical regardless of the intended purpose of the model. Maintaining a high degree of fidelity, however, creates a paradox for model builders because the more closely the model describes or prescribes activities, the less applicable the model is to general use (Dorsey et al., 1997). Additionally, maintaining high fidelity for a model with prescriptive intent can imply inflexibility for those using the process. Thinking of process models as rigid, lockstep prescriptions for activity is one of the major issues with the old paradigm of ISD (Gordon & Zemke, 2000; Zemke & Rossett, 2002).

A more pragmatic approach is to think of models as a guide, rather than as a strict set of rules (Molenda, Pershing, & Reigeluth, 1996). This way of defining a model for design is more realistic for thinking about the way that activities occur in a real-world environment. As discussed earlier, ISD models were originally conceived to improve efficiency in mass-producing training materials for military and industrial settings. The modern paradigm of an information society, however, limits the value of models intended to produce training for the masses (Reigeluth & Nelson, 1997). Increasing needs for training mean that there is still a need for efficiencies in how instruction is developed and models can still deliver some of this efficiency.

Another way to view ISD process models is as a mode of communicating. McCombs (1986) states, "In addition, because the ISD process is typically implemented by a team of instructional designers and subject matter experts, the common language established by the model and its procedures facilitates communication among team members" (p. 68). It is this use models as a framework for communication that guides the process development in this dissertation.

Mitchell (1993) claims that a common language among a design team is formed through the work of design itself and emerges as a result of the activity. While common activity eventually creates a common language, the process is difficult and time-consuming. In a production-oriented environment, a balance must be created between the more organic formation of a common language and the need for efficiency. A well-defined process can improve efficiency by establishing project boundaries and an initial point of understanding for team members.

While models can serve as a communication tool (cf. McCombs, 1986), they can create more specialized languages that make a community less transparent by instantiating arcane terms and acronyms. In his critique of architectural design, Alexander (1979) calls such specialized languages barriers to effective design. If an architect is unable to communicate with the inhabitants of a structure, then the result is a building that is theoretically perfect but unsuited for the needs of the inhabitants. He notes that what is needed is a return to pattern languages that used to serve as a universal transmission exchange medium.

Similar to architects, instructional designers have sought to establish an identity through language and there are even books dedicated to formalizing the terminology of the field (cf. Seels & Richey, 1994). Unfortunately, the language is rarely understood outside of the community of instructional designers and we risk building our own uninhabitable learning structures by separating ourselves from our users. The risk is even greater within the current learning object-based approaches, which are specializations within a specialized field. Creating an ISD process that incorporates through shared language, rather than separates, users of instruction offers the possibility of more usable structures.

An ISD process that serves as an effective communication tool must help to build a shared understanding of activities and processes among the design team. If that team includes user-designers, then the model should reduce the language barrier for becoming a functioning member. To have a process model that can enhance understanding not only among the instructional design team but also among users, an emergent approach to model development will be utilized. The goal is to create a model that can form the basis for a living pattern language among all of the participants in a design effort and provide a bridge between current modes of mass production and scalable personalization.

Chapter 3: Method

Gibbons and Bunderson (2004) describe three types of research: explore, explain, and design. Each type of research should inform the others and provide new inputs into disciplined inquiry. They further note that, despite the relatively short history of design research, all three forms of research are becoming increasingly important in a technologically sophisticated society. Design research has a different focus than other types of research because the intent is to provide prescriptive, rather than descriptive knowledge (Reigeluth & Frick, 1999).

Developmental research, a term synonymous with design research (Reeves, 2000), can be used to generate different types of knowledge. Richey, Klein, and Nelson (2003) describe Type I research as focusing on a single instance of production to give highly detailed descriptions of specific methods, usually through case studies. Type 2 developmental research, however, is geared toward understanding and building knowledge about ISD process, rather than examining a particular outcome or strategy. Recent examples of Type 2 developmental research on ISD process include work by Plass and Salisbury (2002), Jones and Richey (2000), and Klimczak and Wedman (1997). The research methods used in each of the examples varied from survey research and observation, to evaluation. Other common methods for Type 2 developmental research for model-building include literature reviews, case studies, Delphi, and think-aloud protocols (Richey et al., 2003).

This dissertation will use formative research methodology, which is a specific form of developmental research that falls within the Type 2 category (Richey et al., 2003). Reigeluth and Frick (1999) describe formative research methodology in the context of instructional design theory but many of the same activities are useful in studying ISD process. Formative evaluation, the basis for formative research, has long been a recommended practice for development to improve instruction before it is used e.g. (Dick & Carey, 1996). Formative research methodology asks similar questions to revise instructional theory, rather than the instruction itself. The data collected from a formative evaluation helps determine "What worked well?" "What did not work well?" and "What improvements can be made to the theory?" (Reigeluth & Frick, 1999) p. 636.

Reigeluth and Frick's (1999) formative research methodology is intended to improve or create design theory, rather than design process, therefore some adjustments to the methodology are required. While data for formative research comes from a variety of sources, they tend to be more reflective of the end-users (e.g. teachers, students) of the theory. For this dissertation, the same three questions are relevant. The data, however, will be derived from the design team (e.g. instructional designer, editor, SME, user, etc.) and will be focused on ISD process, rather than on the results of instruction.

Research Questions

The research questions reflect the use of formative methodology and the emergent nature of new model development.

Goal: Develop and formatively evaluate model a user-centered design and development process for creating learning objects.

1. What worked well in the use of the process?
2. What did not work well in the use of the process?
3. What improvements or revisions can be made to the process?

Formative Methodology

While there are many ISD process models that will provide input for the development of this model, the emergent nature of learning object development requires some different considerations. Therefore, this dissertation will utilize the steps described by Reigeluth and Frick (1999) for new theory combined with some of the process steps used for looking at an existing theory [ISD process model] development. The following five steps will be used to develop the model (p. 638):

1. Create a case to help you generate the theory
2. Collect and analyze formative data on the instance
3. [Develop a tentative process]
4. Revise the instance [Identify a second, similar instance]
5. Repeat the data collection and revision cycle
6. Fully develop your tentative theory [ISD process model]

The modifications noted by brackets above are the result of considering that the "instance" is a development cycle, rather than a particular unit of instruction. Step three is creation of some level of documentation to enable the use of the process in a second instance. Since development of a specific course is unlikely to occur twice, it is necessary to look for a similar instance in order to test the process, rather than attempting a revision of the original effort as Reigeluth and Frick (1999) describe in creating an instructional theory.

Step1: Design a Case

A case will be designed to utilize a team from a sales training organization within a large pharmaceutical company to develop the ISD process model. The sales training development group has several design teams that create a variety of instructional interventions. The sales audience is segmented into different sales forces, each with different product mixes. Many of the design interventions involve building fact-based modules for sales representative product knowledge. It is anticipated that the first iteration of development will occur with a relatively "low stakes" project that would not place any business-critical needs in jeopardy

The designed case will be the development of a short instructional course (roughly 2 hours of instructional content) on the use of medical reprints for sales representatives. Medical reprints are copies of clinical studies from peer-reviewed medical journals that relate to the products that a particular sales representative carries. The course will utilize some existing content but much of the course will have to be developed during the project. It makes a good case for this dissertation because there are multiple sales forces each responsible for different products. There will be an opportunity to create reusable components so that the basic elements of understanding research papers can be reused, while other elements can be customized to the specific needs of a particular sales force. Additionally, the limited duration of the course (about 2-hours of content) means that it is a more manageable case for study.

It is important to note that this course is being developed in an environment where no formal electronic learning objects exist. This means that any reusable components from this course will form the basis for future reuse efforts. While I will attempt to find ways to reuse some components built in this first effort, the limited number of objects and the realities of being in a naturalistic setting may threaten the feasibility of reuse in this dissertation.

While there will be a team developing the instruction, I will be actively involved with the project. My role will be to provide expertise around user-centered design and the use of learning objects. Such participation is generally required in an initial designed case because there is a need for the person familiar with the principles and intent of the model (Reigeluth & Frick, 1999).

Step 2: Collect and analyze formative data

The data collected will primarily come from the design teams through observation, interviews, and documentation. The focus will be to identify replicable elements of the ISD process and determine how to guide future practice. Given that this is the first instance, emphasis will be on gathering data on the strengths, weaknesses, and possible improvements for the process.

Observations

Observation will occur throughout the development effort in an attempt to gather data about the nature of the environment and conditions in which the process is used. Opportunities for observation will occur primarily during team development meetings. The goal of the observations will be to understand the nature of the development activities and how the tasks are performed.

The nature of the observations will be largely unstructured given the nature of involvement that I will be required to have during some elements of the process. While such participation creates issues related to validity, it allows for more insight into real-time process development (Kemmis & McTaggart, 2000).

Interviews

As suggested by Reigeluth and Frick (1999), interviews will be conducted both during the development effort and after it is over. The interviews during the project will serve to provide input into whether the principles and framework provide a meaningful guide to practice, while the post-project interviews will be intended to have participants:

1. Describe what worked well
2. Describe what did not work well
3. Provide feedback to improve the process
4. Reflect on their activities and determine how they would describe these activities to others

While the complete context of the interviews cannot be determined because the participants will be actively shaping and changing the data gathering process (cf. Holstein & Gubrium, 1995), some specific questions for the interviews will be used to initiate and guide the discussion:

1. What were the issues you had to consider to maximize reusability?
2. What is the best way to represent your design experience to other practitioners?
3. How could the design process be improved?
4. What difficulties did you encounter during the process?

5. How would you visually diagram your experience in a way that would help you to communicate to someone having to do this process?

Documents and artifacts

Documents that are anticipated to provide value include calendars, meeting notes, email, and artifacts of the design process. Documents and other artifacts provide evidence of activity and can either become a focus of the inquiry or merely provide supporting contextual background (Hodder, 2000). The minimal expectations of the artifact analysis will be to provide temporal markers for verifying development activities.

Analysis

The emergent nature of this study will require flexibility during the analysis of the data. Analysis will begin even during the data collection and may require alteration of data collection to focus on areas of strength or weakness, as they become evident (Reigeluth & Frick, 1999). Credibility of the data will be improved through several means. Triangulation among the sources will serve to clarify meaning by utilizing a variety of perceptions to clarify meaning of the data (Stake, 2000). Additionally, member checking will be utilized to verify my interpretations by sharing my understanding of the meaning of the data with participants. As with any study involving qualitative data, my own assumptions and biases will have to be made clear to the reader (Creswell, 1998).

Step 3: Develop a tentative process

Based on the data collected in the previous phase, an initial process with basic guidance will be created. The creation of the guidance is expected to include a collaborative effort among the team to instantiate the process in a way that the team believes would work to provide guidance for future ISD efforts. It is likely that the results of this first instance will include a number of recommended improvements based on the data collected.

Steps 4-5: Repeat the data collection cycle

A second, similar instance will be identified to implement the process guidance established during the first instance. The initial process guidance will be given to a different development team within the same sales training group of a large Midwestern pharmaceutical company. While this team's project will have a number of common elements with the original team, the nature of the instruction and the team members might be different. A similar data gathering and analysis effort will be undertaken that includes observation, interviews, and documents. The intent will be to understand which elements of the model are situation-dependent and which are more generalizable to broader development efforts.

The data gathered for the second instance will follow the same process as described for the first instance. There will, however, be a difference in that this team will be using the first instantiation of the model as a guide, rather than developing the model from scratch. Significant revisions are to be expected but, unlike the first iteration, the focus will be more on differences in situations that can help to broaden the generalizability of the model (Reigeluth & Frick, 1999). Clearly recognizing what Reigeluth and Frick call "situationalities" allows those who might use this work for additional research or future application to precisely understand elements that might cause differences in the use of the model. I will provide as much detail as possible about the differences in context. With only two closely related iterations, however, it should be clear that the expectation is the development of a tentative model and future research should include replication in other situations.

It is expected that the second project will involve a course that is an introduction to the pharmaceutical industry. Similar to the first instance, this course is one well suited for an object-based approach because elements of the course can be re-used for different departments across the company. This course will also have an instructional duration of approximately 2-4 hours. Due to the naturalistic setting, it is possible that business conditions might warrant a change in the exact course content to be developed.

Step 6: Develop tentative ISD process model

Based on the two separate development efforts and data collection, a tentative process will be created to guide teams in future ISD efforts. While this model will still be tentative, it is hoped that it will provide the basis for additional research on effective and efficient processes for the creation of learning object-based instruction. The write up of the tentative process will comprise the fifth chapter of the dissertation and the sixth chapter will discuss limitations of the model and the research and provide suggestions for future opportunities for developing the model.

Expected timeline

The current project timeline is for a two-month development cycle timeline, beginning in September 2004 with completion anticipated by the end of October 2004. Given that this is a real business environment, there might be unanticipated events that cause timeline alterations. The analysis and development of the initial model is expected to follow over the next two months. The second iteration, which will implement the initial model, is expected to occur from January to March of 2005. The data from the second iteration will be analyzed and tentative model will then be proposed by June 2005.

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Figure Captions

Figure 1. The taxonomy of ISD models as presented by Gustafson and Branch (2002). p.14

Figure 2. The Dick et al. (2001) ISD process model.

Figure 3. The Seels and Glasgow (1998) p.178 ISD process model.

Figure 4. The Dorsey et al. (1997) p.449 collaborative rapid prototyping model.

Figure 5. The Frick and Boling (2002) p.1 ISD model for WBI.

Figure 6. The Barritt and Alderman (2004) p.4 RLO ISD model.

Figure 7. The LODAS theory learning object taxonomy (Wiley, 2000b). p. 21-22

Figure 1

Selected Characteristics	**Classroom Orientation**	**Product Orientation**	**System Orientation**
Typical Output	One or a few hours of instruction	Self instructional or instructor-delivered package*	Course or entire Curriculum
Resources Committed to development	Very Low	High	High*
Team or individual effort	Individual Effort	Usually a Team*	Team
ID Skill/ experience	Low	High	High/Very High*
Emphasis on development or selection	Selection	Development*	Development*
Amount of front-end analysis/ needs assessment	Low	Low to Medium*	Very High
Technological Complexity of Delivery Media	Low	Medium to High*	Medium to High*
Amount of Tryout and Revision	Low to Medium	Very High*	Medium to High
Amount of Distribution/ Dissemination	None	High*	Medium to High

Figure 2

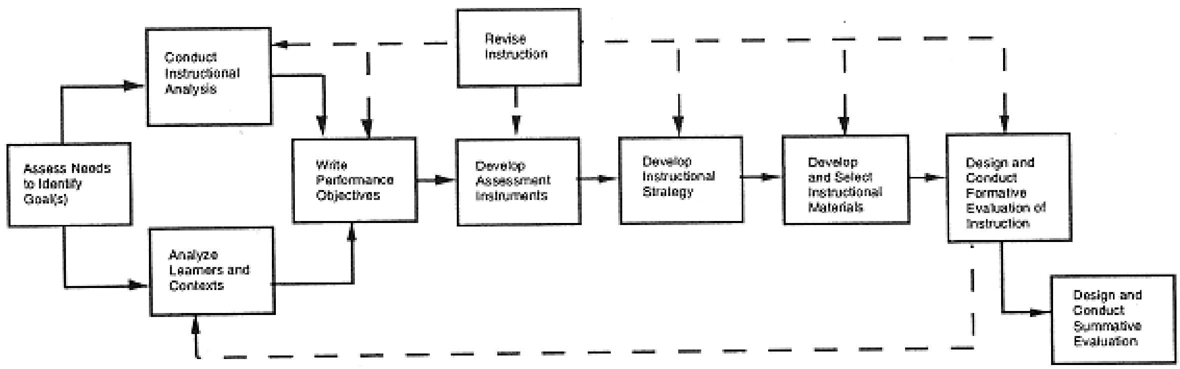

Revise Instruction
Conduct Instructional Analysis
Assess Needs to Identify Goal(s)
Write Performance Objectives
Develop Assessment Instruments
Develop Instructional Strategy
Develop and Select Instructional Materials
Design and Conduct Formative Evaluation of Instruction
Analyze Learners and Contexts
Design and Conduct Summative Evaluation

Figure 3

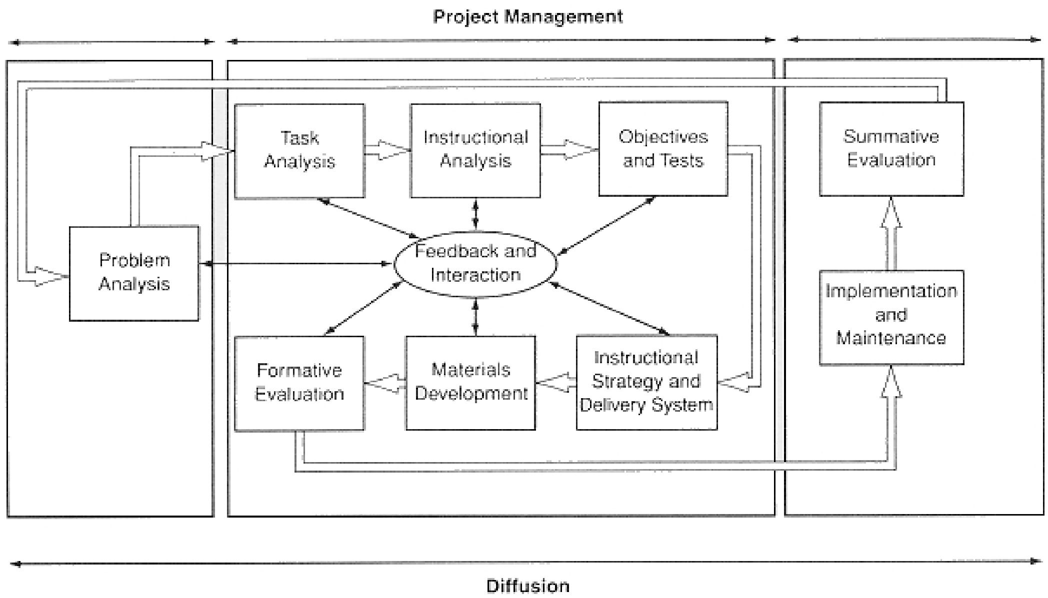
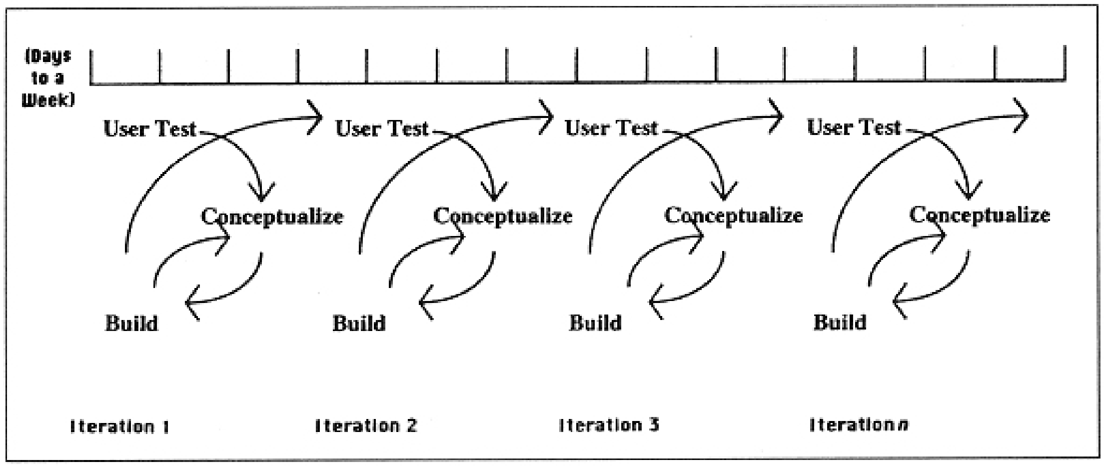

Project Management
Task Analysis
Instructional Analysis
Objectives and Tests
Summative Evaluation
Problem Analysis
Feedback and Interaction
Implementation and Maintenance
Formative Evaluation
Materials Development
Instructional Strategy and Delivery System
Diffusion

Figure 4



TERMINOLOGY

- **User Test** — The experience of the user operating the application in the conducting of real tasks
- **Conceptualize** — The addition and refinement of problem definitions and of solution requirements
- **Build** — Realizing the additions and refinements in the application prototype

Figure 5

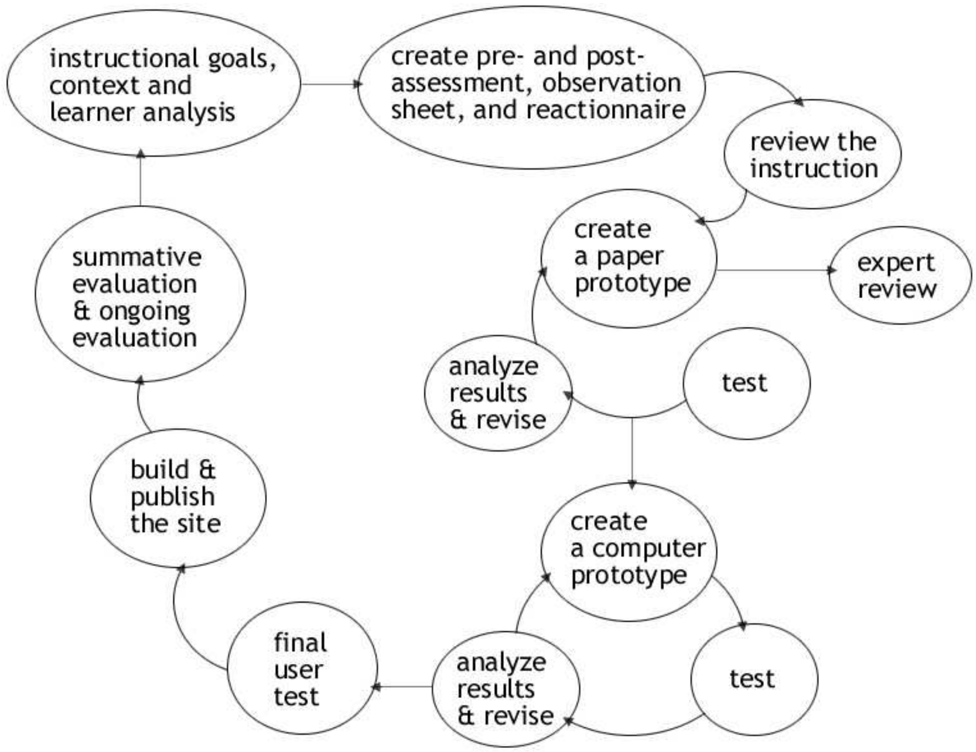

instructional goals, context and learner analysis
create pre- and post-assessment, observation sheet, and reactionnaire
review the instruction
create a paper prototype
expert review
test
analyze results & revise
create a computer prototype
test
analyze results & revise
final user test
build & publish the site
summative evaluation & ongoing evaluation

Figure 6

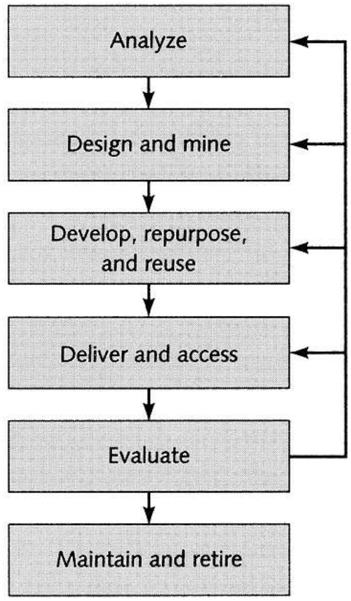

Analyze
Design and mine
Develop, repurpose, and reuse
Deliver and access
Evaluate
Maintain and retire

Figure 7

- *Fundamental* - For example, a JPEG of a hand playing a chord on a piano keyboard.
- *Combined-closed* - For example, a video of a hand playing an arpeggiated chord on a piano keyboard with accompanying audio.
- *Combined-open* - For example, a web page dynamically combining the previously mentioned JPEG and QuickTime file together with textual material "on the fly."
- *Generative-presentation* - For example, a JAVA applet capable of graphically generating a set of staff, clef, and notes, and then positioning them appropriately to present a chord identification problem to a student.
- *Generative-instructional* - For example, an EXECUTE instructional transaction shell (Merrill, 1999), which both instructs and provides practice for any type of procedure, for example, the process of chord root, quality, and inversion identification.