THE BLENDED LEARNING ENVIRONMENT WITHIN THE ROYAL NETHERLANDS AIR FORCE: In search for a systematic, integral development approach

Eddy Boot, M.Sc.
TNO Human Factors
Department of Training and Instruction
Soesterberg, The Netherlands
boot@tm.tno.nl

Wouter Jan Smeulers
LogicaCMG
Division: Systems Development
The Hague, The Netherlands
wouter.jan.smeulers@logicacmg.com

ABSTRACT

In this paper we discuss the problem of combining advanced instructional design with state-of-the art e-learning technology into an effective blended learning environment. Advanced instructional design refers to modern approaches towards training: task oriented instruction, competency-based learning, and learning by doing. This implies a mix of different instructional methods to achieve optimal transfer of training (effectiveness driven). State-of-the art e-learning technology refers to modern approaches towards training delivery: distributed learning and virtual environments. This implies a mix of different delivery mechanisms and standardized learning content to achieve optimal flexibility and reusability (efficiency driven).

A combination of both aspects is called a blended learning solution. Conventional training methods (e.g. classroom based instruction) are used when they are appropriate or practical. Digital training methods (e.g. individual or collaborative learning in virtual environments) are used where distribution or individualism is in order and the educational turnover will not be negatively influenced. A major problem is that combining different instructional methods and delivery mechanisms causes an increased complexity in the already complex process of specifying, developing and implementing learning environments. Such an effort requires a holistic perspective on the development process. However, currently, not much concrete guidelines, Instructional Systems Development (ISD) models, or best practices are available for blended learning. Particular the transfer between Instructional Design and production of learning content is often problematic.

In this paper, we discuss our experiences with Blended Learning projects in the Royal Netherlands Air Force (RNLAF) and in creating a systematic, integral approach towards specifying and developing blended learning environments. This discussion is based upon a heuristic model of a blended learning environment, the Four Quadrant model. We seek to connect to best practices in the IT industry (like using the object orientation as a basis for our design models) and conventional Instructional Systems Development (ISD) techniques as a fundament for our systematic, integral approach. Important elements of the systematic, integral development approach are a) specifying criteria in each phase, b) evaluation of intermediate products by means of these criteria at the end of each phase, c) template-based specification and development, and d) case-based reflections on critical events.

ABOUT THE AUTHORS

Eddy Boot is a scientific researcher at TNO Human Factors, and is involved in research and developments projects concerning the application of Information and Communication Technology (ICT) to improve learning processes. He holds a degree in instructional technology and specializes in applying modern instructional theories like case-based learning and problem-based learning by means of advanced learning technology. Much of his research is related with the integration of work and learning ant the standarisation of learning technology.

Wouter Jan Smeulers is a senior consultant, active in the field of educational innovation, supported by Information and Communication Technology (ICT). In his role as competence manager e-learning he benefits equally from his didactical background, activities as a systems developer and experiences in project management. He focuses on defining and developing standardized advanced blended learning environments.

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INTRODUCTION

The Royal Netherlands Air Force (RNLAF) is currently in a process to modernize their training methodology. This modernization is required to meet the current and future demands of the organization. Whilst the number and backgrounds of new personal will vary considerably, new tasks are introduced, as new (kinds of) (joint) operations are conducted, new systems are introduced, new maintenance doctrines will be applied etc. This results in a demand for different kinds of skills. Therefore, training to prepare new and existing personnel must be qualitative good (ensuring enough personnel is able to do their tasks properly) and flexible (ensuring personnel will be trained just-in-time and just-enough, in as little time as possible). For a more detailed discussion about the new demands for Air Force training, see the paper in this proceedings of Bernards & Hylkema (2003). In order to meet these new training demands, the RNLAF focuses on balancing between optimal effectiveness and efficiency of training.

Effectiveness: instructional design of training

In order to ensure optimal quality and transfer of training, a new approach towards instruction is required. In the traditional situation, instruction was knowledge based: directed at what a learner is required to *know.* Most knowledge was conveyed by classroom-based instruction by rather passive transmission of information. Practice was used to demonstrate knowledge. This resulted in insufficient transfer to the workplace and long, inflexible learning trajectories. In the new approach, instruction should be more task-directed, aimed at what a learner is required to *be able of*. Practice should drive the learning processes, rather than acting as an example of the knowledge previously taught (Jonassen, 1999). Also, learning should be integrated with work where possible. This so-called competency-based approach (Van Merriënboer, Clark, & de Croock, 2002; Van Merriënboer & Kirschner, 2001) is implemented by means of learning by doing, exemplified by instructional models like problem-based learning, project-based learning, case-based learning, collaborative learning etc. Central in this competency-based approach is learning to coordinate and integrate complex skills in such a way that transfer to the workplace occurs in such a way that one is able to solve familiar, but also novel problems (Van Merriënboer, 1997).

Efficiency: delivery of training

In order to ensure optimal flexibility of training, a blended mix of delivery mechanisms (by means of the art e-learning technology) is required to enable learning anytime, anywhere, at any pace. Multimedia presentations and interactive multimedia instruction can support classroom lessons. E-learning modules can support distributed learning independent from place, time and pace. Virtual environments (simulations of processes, emulations of systems) can support practicing exercises in realistic but safe environments, in order to integrate learning and working. Learning Content Management Systems (LCMSs) enable efficient creation and management of learning content, whereas Learning Management Systems (LMSs) enable efficient delivery of learning content. Future (combinations of) e-learning systems are said to be able to provide truly adaptive learning: just-in-time, just-enough, just-for-me (Rosenberg, 2000).

Blended learning

For each particular training application, a cost-effective balance between effectiveness and efficiency must be applied. Such a combination is called a *blended learning* solution. For example, conventional training methods (e.g. classroom based learning) are used where they are appropriate or practical. Digital training methods (e.g. individual or collaborative learning in virtual environments) are used where distribution or individualism is in order and the educational turnover will not be negatively influenced. On first sight, these combinations are logical and complementary, and when combined in powerful learning environments they promise a more optimal way of learning. However, in a number of projects, we found that it is exactly this blended combination that makes it also very complex to specify, develop and implement such modern blended learning environments.

For describing the 'problem space' of blended learning, we use a conceptual model, namely the Four Quadrant (4Q) model depicted in Figure 1.

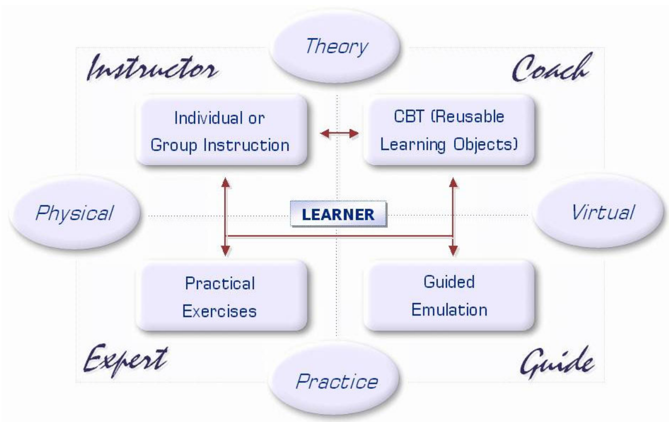

Figure 1. The Four Quadrant (4Q)-model

The 4Q-model represents the different dimensions of blended learning. The first dimension, the vertical axis, represents the instructional design aspects of integrating theory and practice, the distribution of learning and working and the scaffolding roles of four different actors surrounding the learner. The second dimension, the horizontal axis, represents the delivery mechanism aspects of integrating physical and virtual components, the distribution of systems and locations and the administrative roles of four different actors surrounding the learner.

PROBLEMS WITH DEVELOPING BLENDED LEARNING

In this section, we will describe problems with developing blended learning, based upon our experiences with two RNLAF blended learning projects.

The first project is the instructional design for the Mechanic Technical Training Package (MTTP), which is to become a blended learning solution for both RNLAF as well as Royal Norwegian Air Force (RNoAF) F16 maintenance engineers. For a more detailed description of MTTP and the instructional design process, see Janssen, Boot & Van Gestel (2003). The purpose of the project was to conduct a competency-based instructional design according to the Four Component Instructional Design (4C/ID) model of Van Merriënboer (1997). The domain of mechanic maintenance is large (900+ hours) and complex (involving 40+ F16 systems). The resulting instructional blueprint should constitute the basis for the development phase, in which interactive multimedia for supporting classroom training, computer-based training modules and an advanced simulation program should be created. A very important aspect was reuse: between countries (Netherlands / Norway) and between different types of learning trajectories (at least five different learner profiles are identified).

The second project is a blended learning pilot project (see also Bernards et.al., 2003). This pilot was conducted to experiment in the RNLAF with new concepts like embedding competency-based learning in e-learning, template-based development, learning object based implementation and standardization of learning content, and advanced e-learning systems. An important objective was to gather experience and lessons learned in order to deduce a systematic development approach that could be used for a number of forthcoming, large-scale blended learning projects.

Based upon these two projects and the organizational setting of the RNLAF (see the related paper of Bernards et.al. 2003), we have identified a number of problems associated with the specification, development and implementation of blended learning projects. The identified problems are particularly associated with the interaction between instructional design for optimal effectiveness and development and delivery for optimal efficiency. We have divided these problems into three categories.

Project Team problems

Implementing complex learning technology into training is always the effort of a project team, consisting of specialists with different but complementary expertise. Normally this is a linear process, in which for each phase, particular specialists contribute their expertise. In the earlier stages of the computer-based training / e-learning paradigm, in the 80's and 90's, the selection of delivery mechanisms was called the 'media-mix'. This selection was traditionally applied in the last phase of the design process, based upon a finished blueprint for the training, and provided the bridge to the development phase. So a linear approach was well suitable. However, in the blended learning approach, the consequences, affordances, limitations and possibilities of the different delivery mechanisms must be assessed much earlier in order to find the correct balance between effectiveness and efficiency. Therefore, different specialists such as instructional designers and developers are now forced to communicate and work together in different phases, in much earlier stages of a project. One can even say that the development process itself becomes also blended! The result is that often there is much discussion and confusion within a project team, about definitions, criteria, methods, decisions, etc.

Even for instructional design experts it appears to be difficult to apply the different, often ill defined, competency-based instructional methods. The same goes for the development phase, in which developers work with different, often state-of-the-art delivery mechanisms. In blended learning, these problems interact, as it is even harder to balance between the different instructional methods and delivery mechanisms. This introduces much uncertainty and dynamics into the development process. This conflicts easily with the logical desire of a professional project team to firmly plan the whole process in advance.

Development support problems

Most current Instructional Systems Development (ISD) models[1] as described in literature (Reigeluth, 1999; Andrews & Goodson, 1981) offer insufficient prescriptive support for blended learning. Concrete, evidence-based guidelines for the integration of the different aspects of blended learning into a consistent learning environment are not yet available. Probably, this is because most descriptive models for competency-based learning are also not very concrete. And most ISD models take traditional didactical models of learning and instruction as a basis, and do not take the new possibilities with regard to modern delivery mechanisms into account. Experiences with full-scale implementation are scarce, so ISD models cannot yet use best-practices as a basis. Also, as most ISD models are ADDIE models[2], they are too rigid and linear to facilitate the iterative development processes required for the blended learning approach characterized by managing change and uncertainty (Verstegen & Van der Hulst, 2000). Whereas recently there is much interest in modern Instructional Design (ID) models (see for an overview (Dijkstra, Seel, Schott, Tennyson, 1997; Reigeluth, 1999), ISD models are not really innovated. This leads particularly to problems in the interface between ID and development/implementation: how to convey the implications of the didactical blueprint to the production team.

Reusability problems

The high cost of content development can potentially be overcome by means of reuse. This can be profitable for providers of content ('create once, sold many') as well for users of content ('bought/created once, used many'). To enable such reuse, learning content is created by means of standardized learning objects (E-learning consortium, 2002). However, it also introduces a number of problems (see also Stout, Slosser & Hays, 2001). First, in the traditional situation, the specification and development starts from scratch, and is aimed at a particular, very specific usage of the content. In the reuse situation, new content can often be developed by combining and/or altering existing content, but must also be developed in such a way that the new content is also reusable. However problems rise in determining the object size of a learning object, making the content of a learning object consistent (e.g. acronyms, style, terminology, cultural conventions), and in adding meaningful metadata for labeling the new content, particularly for indicating the proper instructional usage of the learning object. Although the first guidelines are starting to appear (see for example Hamel & Ryan-Jones, 2002), these questions are not yet addressed sufficiently to support developers adequately. Second, existing content is ideally retrieved from large repositories, but it appears to be difficult to find relevant learning objects on the basis of the current, limited sets of metadata (Boot & Bots, 2002). Also, it is difficult to combine the different, retrieved learning objects into meaningful and consistent new blended learning content. Third, the learning technology standards[3] that prescribe how learning objects should be structured and combined in order to be interchangeable (reuse between courses) and interoperable (reuse between e-learning systems) are mostly not yet real standards but only specifications. This implies that they are still changing (sometimes considerably). Also, these

[1] Note that the in some corporate and military settings these ISD models are called Systematic Approaches to Training (SAT) models. Both have in common that they provide prescriptive guidelines for developing (technical) training solutions for a particular learning need, in a systematical, phased manner. The first two phases of an ISD model (Analysis and Design) are often labeled Instructional Design (ID) models.

[2] ADDIE: Analysis, Design, Development, Implementation, and Evaluation. These are the most common five phases in ISD models, often described in a linear way (also called the waterfall model).

[3] See the IEEE LTSA website (www.edutool.com/ltsa). for a comprehensive overview of learning technology standards initiatives.

specifications are hard to understand for those without (technical) knowledge on this on this topic.

TOWARDS A SYSTEMATIC, INTEGRAL DEVELOPMENT APPROACH

Based upon our experiences in RNLAF projects and the identified problems described above, we have tried to combine an advanced instructional design with state-of-the art e-learning technology into a systematic, integral development approach towards blended learning. It is systematic in terms of logical, iterative steps that are continually evaluated in order to guarantee the quality of the process. It is integral in terms of taking a holistic, transparent perspective suitable for competency-based learning. It particular emphasis on bridging the gap between instructional design (i.e. specification) and development (i.e. production).

As we will discuss in this section, we've standardized the necessary steps to determine for each training need how the create a blended learning solution as described by the 4Q model. The design process is specifically based upon the 4C/ID model. This model provides prescriptive guidelines how complex cognitive skills (or competencies) can be analyzed and how instruction can be designed that emphasizes learning to integrate and coordinate these complex cognitive skills. The end-result of this analysis and design process is an integral blueprint of the training. In our view this is a didactical design already adapted to the environment it will be delivered in (according to the 4Q model, this can either be a physical or a virtual context or some kind of combination). After that, the development process starts. This is a rather straightforward activity where the only creativity allowed is reflected by the skilled copywriter or multimedia developer. Figure 2 depicts the whole systematic, integral approach.

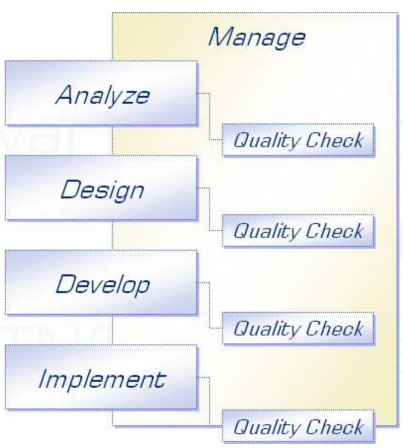

Figure 2. Phases of the development approach

The complete development process consists of five stages, and on first sight resembles the traditional ISD/ADDIE models. However, there are some important differences. Most important is that it allows for some kind of rapid prototyping (Tripp & Bichelmeyer, 1990). By using templates for both the design as well as the development process, one is able to create easily and rapidly prototypical blueprints and products, which can be tested and evaluated. This provides useful information about the validity of the (blended) solutions in an early phase of the process. This implies that in each (part of) a phase the optimal balance between effectiveness and efficiency can be (re)considered.

Manage

The 'Manage' Phase is part of the organization in which the development 'project' takes place. It concerns Project Management, Quality Management, Formative and Summative Evaluation and the Maintenance of any product of the different stages (e.g. courseware, manuals and lessons learned). In each phase, the didactical, technical and organizational criteria are specified for that phase. At the end of each phase, the products of that phase are compared to these criteria in a Quality control check. Based upon that check, it can be decided to progress to the next phase, or to repeat (parts of) the next phase.

Analysis

The Analyses Phase is concerned with the prerequisites for all subsequent activities. First, it is estimated how much the effort this phase will cost. If it is considered not a large effort, it is executed in one part. If it is considered to be a large effort, it is divided in parts (for example first for a particular learner group or task). So if the Quality check (see the end of this phase) indicates that the analysis approach is not satisfactory, minimal time is lost. The Analysis phase should provide answers the following questions:

- Who are the end-users of the course? What are their needs and characteristics?
- What are the technical and physical limitations for the to be developed content?
- Are there any guidelines or specific policies with respect to the organization?
- What is the didactical context of the course? Is there overlap with other material (reuse!)?
- What are the central tasks to be performed?
- What are the courses objectives (behavior, conditions, and criteria for (minimal) performance of this task)?
- What are the underlying competencies for each task?

A style guide is created, describing the prerequisites and looks and feels of the different types of learning objects in this training situation. The style guide also describes the relation between a particular didactical component (see next phase) and a range of *possible* delivery methods (computer-based training, simulation or group instruction etc.) in this training situation.

Finally, the first Quality check is conducted. A board of representative stakeholders (management, policymakers, didactical experts, subject matter experts etc.) will judge the produced documents and style-guide. If they are sufficient, the Design phase may start. If they are insufficient, (parts of) the Analysis phase will be repeated.

Design

The Design Phase focuses on providing a didactically sound instructional design based upon the fundaments of the 4C/ID model (also discussed in the papers of Bernards et. al., 2003 and Janssen et.al., 2003). To reach this, we take the following steps:

- Analyzing the course objectives / job requirements (tasks)
- Grouping the tasks in a hierarchical structure, combining related tasks in task classes. Within a class the tasks are sequenced, showing increased complexity.
- Estimate the complexity of the training and the design effort. If it is considered as a low complexity and/or not a large effort, the next steps are executed in one part. If it is considered to be complex and/or a large effort, only one task class / blueprint is composed. So if the Quality check (see the end of this phase) indicates the design approach is not satisfactory, minimal is lost
- Per task class the 4C/ID blueprint is composed, defining learning tasks with underlying learning and training needs.
- Each blueprint is then transformed in a logistical plan on how to present the four components of a 4C/ID learning environment: learning tasks (presenting whole task practice for routine and non-routine skills), supportive information (presenting elaborated information required to perform the learning tasks beforehand), just-in-time information (presenting restricted information during practice) and part-task practice (presenting additional practice to automate routine skills).
- Each component provides explicit or implicit indications how they fit best in the different quadrants of the 4Q model.

The style guide from the previous phase is applied to the blueprint. This means that the blueprint transforms into a delivery plan, describing the contents *and* appearance of the learning object to be delivered. This is done by carefully comparing the preferred delivery method of the style guide with the data from the Analyses Phase (the organizational and technical restrictions). This leads to a situation specific, optimal choice regarding the delivery method. The result is the definite instructional design, containing all information necessary for the next phase, leading to the development of the right means for training, whether is will be CBT, simulation (emulation), folio or conventional means of skill transfer (see the 4Q-model).

Optionally, by using template-based tools[4], designers can create small, prototypical parts of the learning content, in order to convey the exact intentions of the blueprints to the developers in the next phase.

Finally, the second Quality check is conducted. A board of representative stakeholders (didactical experts, instructors, subject matter experts etc.) will judge the produced documents and delivery plan. If they are sufficient, the next cycle of the Design phase (i.e. the next task class / blueprint may start). If it is insufficient, (parts of) the Design phase will be repeated. If all cycles are approved, the Development phase may start.

Development

The Development Phase focuses on producing the blended learning environment by means of the delivery plan, leaving the developers as little room for free interpretation as possible.

- Where possible, the development is divided also in cycles, based upon (parts of) a blueprint, (components of) a delivery system etc.

Finally, the third Quality check is conducted. There are two possibilities, which can also be combined. First, a board of representative stakeholders (management, technical experts, didactical experts, instructors, subject matter experts etc.) judge the produced learning objects / learning environment. Secondly, a (small) group of learners is presented a prototypical (part of) the training and their learning processes and results are evaluated. If the results of are sufficient, the next cycle of the Development phase (i.e. the next blueprint or delivery system) may start. If it is insufficient, (parts of) the Development phase will be repeated. If all

[4] Template-based development tools are so-called zero-programming tools that provide pre-structured didactical templates, which allow even inexperienced developers to create interactive multimedia programs.

cycles are approved, the Implementation phase may start.

Implementation

The Implementation Phase focuses on embedding the blended learning environment in the organization.

- Where possible, the implementation is divided also in cycles, based upon (components of) a delivery system etc.

Finally, the fourth Quality check is conducted. There are two possibilities, which can also be combined. First, a board of representative stakeholders (management, technical experts, didactical experts, instructors, subject matter experts etc.) judge the implemented learning environment. Secondly, a (small) group of learners is presented (a part of) the training and their learning processes and results are evaluated. If the results are sufficient, the next cycle of the Implementation phase (i.e. the next (components of a) delivery system) may start. If it is insufficient, (parts of) the implementation phase will be repeated. If all cycles are approved, the Maintenance Phase may start, which is responsible for didactical or technical upgrades of the blended learning environment.

CONCLUSION AND FUTURE DIRECTIONS

The specification, development and implementation of blended learning is a complex endeavor. As described in the 4Q model, a blended learning environment involves many actors and aspects. Based upon our experiences and identified bottlenecks, we've created a systematic, integral development approach towards blended learning. We will apply this new approach in a number of upcoming RNLAF blended learning projects. In these projects, we need to refine and adapt the method on basis of the development of new theories and descriptions of best practices. This requires much attention to introduce such heuristic models to the project team, in order to let them become adaptive in such dynamic, changing development situations. Also, it is very important that these processes are embedded in the organization by policy formulation and experience is required in such new situations. Stakeholders like management must be aware beforehand that the processes towards blended learning can be very blended as well!

In our experiences with developing blended learning environments, we found that prescriptive guidelines are not available, but also probably not very useful. Guidelines are generalizations, induced from many, somewhat similar experiences. However, each blended learning implementation requires such a specific and unique mixture of instructional methods and delivery mechanisms, that generic guidelines lose their prescriptive value. Therefore we want to explore whether it is possible to gather concrete case-descriptions, which incorporate the rich context, underlying reasoning and lessons learned of solved problems in the whole development process. Writing narrative cases leads to reflection on critical events and helps to make implicit knowledge more explicit. This is therefore beneficial for a project team member that writes such a case, but also for other team members (or members of other teams facing similar problems) as this can support hem in solving a same or analogous problem (Kolodner, 1993, 1997). Cases can be stored and managed by means of some sort of a project database, and indexed according to particular problems that occur during particular phases in the development method, or be related to particular aspects of the 4Q-model.

REFERENCES

Andrews, D.H., & Goodson, L.A. (1980). A comparative analysis of models of instructional design. *Journal of Instructional Development, 3*(4), 2-16.

Bernards, A.J.C., & Hylkema, W. (2003). The blended learning environment within the RNLAF, in an organizational perspective. *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2003.*

Boot, E.W., & Bots, M. Learning Object Creation, Management and Reuse by Non-experienced Content Developers. *Proceedings Interservice/Industry Training, Simulation and Education Conference 2002.*

Dijkstra, S., Seel, N.M., Schott, F., & Tennyson, R.D. (Eds.). (1997). Instructional Design: International Perspectives.

E-learning Consortium (2002). Making Sense of Learning Specifications and Standards. Industry report by The Masie Center. (www.masie.com).

Hamel, C.J. & Ryan-Jones, D. (2002). Designing instruction with Learning Objects. *International Journal of Educational Technology November 2002.*

Janssen, N., Boot, E.W. & Van Gestel, M. (2003). New way of organizing F16 maintenance training: blended learning solution. *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2003.*

Jonassen, D. H. (1999). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional-design theories and models*, 2nd Ed. Mahwah, NJ: Lawrence Erlbaum Associates.

Kolodner, J.L. (1993). *Case-based reasoning.* San Mateo, CA: Morgan Kaufman Publishers, Inc.

Kolodner, J.L. (1997). Educational Implications of Analogy, a view from case-based reasoning. *American Psychologist (52).* Pp. 57-66.

Reigeluth, C.M. (Ed.) (1999). *Instructional-design theories and models, 2nd Ed.* Mahwah, NJ: Lawrence Erlbaum Associates.

Rosenberg, M.J. (2000). *E-learning, strategies for delivering knowledge in the digital age.* McGraw-Hill: New York.

Stout, R.J., Slosser, S.J, & Hays, R.T. (2001). Sample Lessons Learned from Advanced Distributed Learning Efforts. *Proceedings Interservice/Industry Training, Simulation and Education Conference 2001.*

Tripp, S., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research & Development, 38(1*), 31-44.

Van Merriënboer, J. J. G., & Kirschner, P. A. (2001). Three worlds of instructional design: State of the art and future directions. *Instructional Science, 29, pp.* 429-441.

Van Merriënboer, J.J.G. (1997). *Training Complex Cognitive Skills.* Englewood Cliffs, N.J.: Educational Technology Publications.

Van Merriënboer, J.J.G., Clark, R.E., & de Crook, M.B.M.(2002). Blueprints for complex learning: the 4C/ID model. *Educational Technology Research & Development (ETR&D), 50* (2), 43-55.

Verstegen, D.M.L., & Hulst, A.H. van der (2000). Standardized development of a needs statement for advanced training means. *Proceedings of the 22th Interservice/Industry Training, Simulation and Education Conference, November 27-30 (pp. 1136-1144). Arlington, Virginia: National Defense Industrial Association (NDIA), National Training Systems Association, (NTSA).*