Formative Evaluation of Instructional Material
Bruce L. Mann

Objectives:
1. Distinguish between different approaches to formative evaluation.
2. List the steps in the Dick and Carey model
3. List the steps in the Alessi and Trollip model
4. Describe the variables in the DECL factors of Web course management
5. List the phases in phase theory
6. Describe the purposes for formative evaluation.
7. Describe the instruments used in a formative evaluation.
8. Develop an appropriate formative evaluation plan and construct instruments for a set of newly created instructional materials, selected or adapted materials, instructor-delivered instruction, or some combination of these.
9. Collect data according to a formative evaluation plan for a given set of instructional materials or instructor presentation.

Formative Evaluation

In a traditional sense, "formative evaluation" is a process of revising material developed according to principles of instructional design. From a recent stand-point, "formative evaluation" is a process of revising material that was designed by any one of six approaches to designing multimedia for learning. These are design by intuition, by technology selection, for balanced input, for cognitive load, for audio-visual sensations, or design by structured sound function. Familiar models and theories of instructional design (e.g., Dick & Carey, 1996; Gagne, 1985) have been found to be too static (Boshier, Mohapi, Moulton, Qayyum, Sadownik, & Wilson, 1997), inert (Yang, Moore & Burton, 1995), or unusable (Wild & Quinn, 1998) for prescribing the conditions of interactive learning for all learners in all settings. Some (Tergan, 1998) believe that instructional design models and theories are based on psychological and educational theories that are simply too broad in scope and too rigid for delivering instruction on hypermedia systems like the Web. For this reason, models and theories of instructional design are hardly ever used with contemporary authoring, multimedia and hypermedia systems, and when they are, are regularly misapplied (Gros, Elen, Kerres, Merrienboer & Spector, 1997).

The Dick & Carey Model

Though there are many others, two models will be reviewed with the learner emphasis in this chapter, the Dick and Carey model, and the Alessi and Trollip process. The Dick and Carey model of formative evaluation has six stages (Dick et al, 2005):
1. Design Review
2. Expert Review
3. One-To-One
4. Small Group
5. Field Trials
6. Ongoing Evaluation

The first four steps are particularly relevant to Web-based educational research.

**Step 1. Design Reviews**
In a design review, the research will ask the following questions:
- ✓ Does the instructional goal match the problem identified in the needs assessment?
- ✓ Does the learner & environmental analysis match the audience?
- ✓ Does the task analysis include all the prerequisite skills?
- ✓ Are the test items reliable and valid, and do they match the objectives?

**Step 2. Expert Review**
In an expert review, an expert reviews the instruction with or without the evaluator present. The experts are usually content or technical experts.
- ✓ Is the content accurate & up-to-date?
- ✓ Does it present a consistent perspective?
- ✓ Are examples, practice exercises, & feedback realistic & accurate?
- ✓ Is the pedagogy consistent with current instructional theory?
- ✓ Is the instruction appropriate to the audience?

**Step 3. One-To-One Review**
In a one-on-one evaluation - one learner at a time reviews the instruction with the evaluator and comments upon it.
- ✓ Is the message clear?
- ✓ What is the impact on learner attitudes, achievement of objectives & goals

**Small Group Try-Out**
In the small group evaluation, the evaluator tries out the instruction with a group of learners in an environment similar to that in which it will be used in the 'real world' and records their performances and comments.
- ✓ Look for the effects caused by the changes made in the one-to-one review
- ✓ Identify any remaining learning problems

**Thesis Research Using Dick and Carey’s Model**
Marcia Gasper completed the EdD degree at the University of Pittsburgh in 2003 with a thesis entitled “A developmental case study of the design and implementation of a web-enhanced nursing health assessment course” (DAI-A 64/07, p. 2456). The purpose of this study was to design, develop, implement and evaluate a web-enhanced nursing health assessment course. The design process itself, as guided by Dick and Carey’s
systems approach to instructional design model was studied. Strengths and weaknesses of the models are discussed, as well as factors related to choosing a Web Course Development Tool (WCDT), choosing a design model, formulating an evaluation plan, and identifying the role of the course facilitator. Emphasis was placed on formative and summative evaluation. Formative evaluation included expert review, one-to-one evaluation, small group, and field trials. The evaluators were an Instructional Technology Specialist (ITS), a subject-matter expert, faculty, and learners. Data sources included an interview protocol and other tools designed by the author. Content analysis was employed for expert and learner responses to the interview and other evaluation instruments.

A course evaluation tool was used to assess learning outcomes, educational practices, and the use of technology for the purpose of benchmarking. Reliability and validity measures were applied to this instrument. Learning outcomes examined include: accessibility, application, connectedness, convenience, satisfaction, and socialization. Educational practices examined include: active and engaged learning, cognitive and creative outcomes, feedback, faculty/student interaction, student/student interaction, and time on task. Factors examined related to the use of technology include productive use of time, technology infrastructure, and prerequisites for using technology. Statistical analysis of coded items of the tool included means (e.g., reported as benchmarks), t-test, and correlations.

The Alessi & Trollip Process

Alessi and Trollip (2001) divide the formative evaluation process into three phases: quality review, pilot testing, and validation. Their three stages correspond to Dick and Carey’s model: one-to-one, small group and the field trial (Dick, Carey & Carey, 2004). Alessi and Trollip divide the process of formative evaluation into three phases: quality review, pilot testing, and validation for conducting a formative evaluation of multimedia prototype (Alessi & Trollip, 2001)

1. Quality reviews by an instructional design and a subject matter expert.
2. A pilot test of the prototype with a student.
3. Validation

Stage 1: The Quality Review

The purpose of a quality review is to eliminate correctable errors. Feedback received from the instructional design and subject matter experts provide the recommendations for revision to your prototype and documentation. An exemplary quality review includes—

- the language & grammar.
- the displays and surface features.
- the use of audio.
- the questions and menus.
- the subject matter.
- the directions & instructions in the documentation.
The procedure for conducting a quality review is as follows:

- Examine the design of your prototype (Alessi & Trollip).
- Dry-run the flowchart of your prototype (in Alessi & Trollip).
- Check the storyboard & audio script for your prototype (Alessi & Trollip; Mann, 1997).

Stage 2: The Pilot Test
The purpose of a pilot test is to debug the prototype and documentation, and correct any obvious problems. An exemplary pilot test is conducted with representatives of the target audience using a 7-step procedure:

1. Select a participant.
2. Explain the procedure to him/her.
3. Determine their prior knowledge.
4. Observe him/her using the program.
5. Interview him/her afterwards.
6. Assess their learning.
7. Take notes on how it could be revised.

Stage 3: The Validation
The third stage in Alessi & Trollip’s formative evaluation is validation of the lesson in the actual setting. The purpose of the validation is: 1.) to verify the results of your pilot test in the real setting; 2.) assess the outliers (i.e those who do really well, those who don’t). An exemplary validation is comprised of the following steps—

1. Consent, relevant background.
2. Pretest.
3. Information, equipment check-out.
4. Think-aloud practice.
5. Work through the prototype.
6. Posttest.
7. Questionnaire.
8. Unstructured interview.

Other Formative Evaluation Thesis Research

Remediation software. In 2004 Anita Kinser wrote a Ph.D thesis at Pepperdine University entitled "Computer-assisted remediation for at-risk nursing students". The purpose of this research was to develop a Web-based interactive computer-assisted remediation software program that could be effective in increasing program success of at-risk nursing students. Previous research has shown that a lack of adequate study skills and test-taking skills is a major factor in the rising attrition rates for nursing students, with not enough resources available to provide remediation to all who need it. The problem presented suggested the need for an inexpensive, effective remediation program related to study skills and test-taking strategies for nursing students.

A three-phase design experiment was used to address the research objectives of (a) developing an interactive remediation program in a Web-based format for use in
assisting at-risk nursing students in improving study and test-taking skills, (b) establishing content validity of the program through alpha testing by faculty with content expertise in teaching and remediation with nursing students and (c) determining student perceptions of helpfulness and ease of use of the tool through a beta test process. The program developed provides assessment and remediation of study skills and test-taking skills specifically aimed at the needs of nursing students in a Web-based format.

Analyses of surveys evaluating the program provided positive results. Evaluation by faculty content experts indicated that the program provides valid assessment and remediation content in a user-friendly manner. Analysis of evaluation survey results from student pilot testers in 2 separate nursing programs (N= 36) found that the program could be a useful tool to help most nursing students strengthen their study skills and test-taking skills. If the computer-assisted remediation program can provide nursing students with resources to increase their potential for success in the nursing program, it would be a cost effective alternative method for assisting nursing students and increasing the number of nursing graduates entering the health care work force.

Heuristic formative evaluation. Patrick Devey’s masters thesis (2002) investigated “The e-volving practioner: A heuristic formative evaluation of an online course, based on an action research methodology”. This thesis made use of limited studies, and combined that knowledge to the experience of practitioners in the field, as well as with the feedback from the participants in the e-Learning environment, in order to devise a set of successful practices for an undergraduate statistics course offered entirely online. In other words, this research aims to successfully implement practical procedures into a Web-based course in order to make it the best possible experience for everyone involved. In accomplishing these goals, this work could then serve as a resource for other practitioners in the field by providing them not just with recommendations for Web-based courses, but also with concrete, proven, and successful interventions in this particular environment.

Electronic portfolio. Jane Costello’s thesis (2002) focused on an “Evaluation of an electronic portfolio template system”. The design, development and formative evaluation of an Electronic Portfolio Template System for Cycle 1 students in the Quebec Education System is described. The prototype is a web-based, database-driven process and showcase portfolio container that facilitates portfolio development. This system contains administrator, teacher and student environments. Each of these environments, along with the installation, set-up and documentation process was evaluated. In all, twenty-six participants evaluated the various environments and processes. Results of all evaluations are presented. The student environment received the most feedback with strengths reported relating to interface design, usability, learnability and aesthetics and weaknesses reported relating to suitability and navigation. Interface design, learnability and aesthetics were reported as strengths while marginal navigation weaknesses were reported in the teacher and administrator environments. Evaluative comments, recommendations for improvement and suggestions for further research are presented.

Factors Affecting a Formative Evaluation

Educational websites, unlike their informational counterparts, are comprised of at least four factors that under certain conditions will affect design and formative
evaluation: Delivery, environment, content and learner, or DECL. Before you begin – think about where you will you be teaching – in a French immersion school, a military training college, a private school, a public school. DECL can help you identify all or at least the major factors we know affect student learning. “DECL” was adapted for distributed learning environments (Mann, 2005, 1995, 1997) from Richey’s conceptual model of instructional design (Richey, 1986). Let’s consider the variables within the DECL factors of Web course management, shown in Figure 0.

<table>
<thead>
<tr>
<th>Delivery</th>
<th>Environment</th>
<th>Content</th>
<th>Learner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Setting</td>
<td>Mental Operations</td>
<td>Attitude</td>
</tr>
<tr>
<td>Presentation</td>
<td>Climate</td>
<td>Task</td>
<td>Capacity</td>
</tr>
<tr>
<td>Strategy</td>
<td>Domain</td>
<td></td>
<td>Demographics</td>
</tr>
<tr>
<td>Sequencing</td>
<td></td>
<td></td>
<td>Competence</td>
</tr>
</tbody>
</table>

Figure 0. DECL factors of Web course management and associated variables.

“DECL” stands for delivery, environment, content and learner factors that comprise student achievement, adapted from Richey’s theoretical and conceptual bases of instructional design (Richey, 1986), and adapted to distributed learning environments (Mann, 1995, 1997). Consult the chapter in this book, “Emphazing the Differences in Web-Based Formative Evaluation” for applications of the DECL factors of Web course management in different educational and training settings.

Delivery

Four variables comprise the “delivery factor”. Your Web course would examine the scope, sequence, strategies, and presentation of the web course. Consideration of the scope would either the mean “big picture” the program, a course or a unit. Or its micro-structure as in a workshop, lesson, even a single objective. Evaluating the sequence of instruction could be examining the ordering of events or activities, or their pacing in the course schedule.

Your instructional materials should employ strategies, including a media mix and the instructional devices. Consideration of the media mix means the design of the audio, video and graphics for possible effects on students cognitive load. Consideration of instructional devices would include a discourse analysis of asynchronous text discussion, asynchronous text chat, or audio conferences. If it’s a hybrid (e.g., web/face-to-face) course, the evaluator might also look at the amount and quality of whole group
instruction, individualized instruction, work-embedded instruction, fault-free questioning, constructed answers, partial answers, elaborative interrogation.

Regarding the Presentation variables involved, it's recommended to consider tactics, which are comprised of six functions, adapted from Gagne’s events of instruction: 1) maintain attention, 2) secure a response, 3) provide reinforcement, 4) maintain interest, 5) facilitate retention, and 6) assess performance. Concerning the form of the presentation, consider how the mix of technologies is encoded, using research on Mayer and Moreno’s “cognitive theory of multimedia learning” (Mayer, 2001), research with Sweller’s “cognitive load theory” (Chandler & Sweller, 1991), and research with Mann’s “structured sound functions (SSF) model” (Mann, 1995, 1997, 2000; Mann, Newhouse, Pagram, Campbell, & Schulz, 2002). Regarding learner control, consider the type and amount of learner control, level of interactions, expository/discovery.

Environment

Two variables comprise the “environment factor”. In preparation for conducting your study, you would do well to account for the learning climate (e.g., K-12 school, business, government, medical & nursing, college, military) and its setting which could be characterized as either online or hybrid (e.g., web/face-to-face).

Content

Three variables comprise the “content factor”. In the content domain, your formative evaluation should examine the mental operations required to learn the content, the tasks involved, and the learning domain. Regarding the mental operations required to learn the content, consider the requirements to select and focus attention, student expectations, and guidance provisions. Is there time for retention, to organize, rehearse for storage, and retrieve and use. Finally there should be advice about learning transfer through lateral, vertical, problem solving or creative thinking activities. Regarding the tasks involved its best to consider everything you can such as the basic skills that are assumed, any gender or cultural concerns, vocational aspects, and personal skills such as time management or goal setting. Concerning learning domains involved, it may be good to know the extent of motor and intellectual skills, verbal information learning and cognitive strategies to augment or supplant learner precepts. Finally, consider the “buy-in factor” in the content, perhaps more accurately called the axiological variable.

Learner

In the learner domain, “attitude” can have a direct effect on student performances in certain learning tasks. Attitudes are defined as likes and dislikes, with roots in social, emotional, behavioral, and cognitive experiences. Attitudes can also be value-laden (e.g., moral and religious beliefs, school pride, or work-ethic), self-concept (e.g., academic, personal, professional), or motivational (e.g., goals, interests, perseverance). “Capacity” relates to innate ability, as opposed to achievement, the competence variable. The definition of ‘capacity’ includes intellectual abilities (e.g., verbal, mathematical, artistic,
and social capabilities), as well as cognitive (e.g., perceiving, remembering, thinking, apprehending, sorting, and utilizing information) and physiological (e.g., perceptual development and motor dexterity) development. Regarding “demographics”, some evaluators like to collect demographic data to apply to their data interpretation. Data shows differences among the learner performances when subjects are categorized on the basis of such variables as age, sex, and cultural background. “Competence” is the result of conscious activity, either a learning experience or another life event. According to Richey (1986), while competence is limited by an individual’s natural capacities, it is influenced by the learner’s attitudes and general profile characteristics. Competence includes prerequisite skills (e.g., information processing skills, basic skills, and content prerequisites) and experiential background (e.g., family, leisure time, social, vocational and educational background).

**Different Emphases in Formative Evaluation**

Successful Web course instructional materials, to some degree at least, are defined by the hosting organization. The host determines the emphasis. A corporate Web course for example, has a different emphasis to that of a school or a religious training college. Figure 1 shows a graphical comparison of the emphasis in three different Web courses (from Mann, 1993, 1995, 1997): a) the educational psychology system with their emphasis on the learner, b) the business or “Management by Objectives” model has an emphasis on the work environment, and c) the DECL factors of Web course management balances the delivery, environment, content and learner factors.

![Figure 1. Differing emphasis in three Web course management systems.](image)

**An Emphasis on the Student**

Traditionally, the predominant emphasis of instructional design and by extension, Web-based instructional design has been the educational psychology model, with its emphasis on the learner (Mann, 1993, 1995, 1997). Figure 2 shows the educational psychology model with the focus on the learner factors.
A Business-Focused Emphasis

A Web course management system is always affected by its sponsor or hosting organization, especially of systematically designed instructional material for corporate and military training, and by extension Web-based instructional design, hereafter referred to as the MBO/Military system of Web course management. A Web course management system offering training to branches in different regions of the country for example, would focus primarily on the environmental factors such as the climate of the organization at the time, as well as the local settings. There is usually less concern with learner factors.

A Balanced Emphasis

Web course management systems like other systems are affected by factors inside and outside itself. Figure 2 shows a representation of a Web course management system with a balance of four factors (DECL) affecting the design and formative evaluation of Web-based teaching and learning. “DECL” stands for delivery, environment, content and learner factors that comprise student achievement. The size of the circles in figure 2 indicate their equal emphasis and equal impact on the rest of the system, and on achievement. Consult the chapter “Introduction to Research Styles on the Web” for details on each of the DECL variables.
Figure 2. A balance of factors in a Web course management system.

**Quick Checklist**

Here’s a quick checklist for conducting a formative evaluation. The process of formative evaluation is one that allows the instructor or instructional designer to make sure that what was intended as a learning environment is actually experienced by the learners using the program. Again, this is particularly critical in instructional design in Web-based instruction, because the designer may not have the opportunity to check

- A content expert
- An expert on web-based teaching and learning
- Two learners who agree to try-out the materials and web tools
- A complete set of web-based materials and tools in draft form
- A description of the range of ability and motivation of the learners
- An explanation of the learning context
References


Mann, B.L. (2005). Making your own educational materials for the Web. International Journal of Instructional Technology and Distance Learning 10(2)


