A Method Engineering Approach to Evaluate Instructional Products

Jonás Montilva[1,2], Judith Barrios[1], and Beatriz Sandia[2]

Universidad de Los Andes
Facultad de Ingeniería, Departamento de Computación,
[1]Grupo de Investigación en Ingeniería de Datos y Conocimiento (GIDYC),
[2]Coordinación de Estudios Interactivos a Distancia (CEIDIS),
Mérida, Venezuela 5101
E-mail: jonas@ing.ula.ve, ijudith@ing.ula.ve, bsandia@ing.ula.ve

Abstract

The evaluation of instructional products is widely recognized as an essential activity of any teaching-learning process. Instructional products, such as online courses, training programs, tutorials, instructional modules, course management systems, and web-based study guides, are required to be evaluated during their development, usage or at the end of the learning process. This kind of evaluation is not a simple process. It demands the use of resources, such as people, tools, methods and time, which must be properly planned and controlled to ensure the efficiency and effectiveness of the process. We describe, in this paper, an evaluation method for guiding educators, teachers, and instructional designers to evaluate different types of instructional products. The proposed method intends to solve problems that were identified in the existing evaluation methods, such as the lack of generality, adaptability and manageability. This method is general, complete, technique independent, well-structured and adaptable. Its design was based on principles and concepts taken from Method Engineering and Software Engineering. It is composed of a process model, a product model, and a team model. These three components are properly integrated in order to effectively guide an evaluation team during the process of evaluating instructional products. Its main contribution is in providing a general methodological framework that can be easily adapted to evaluate a variety of instructional products.

Key words: Distance Education, Instructional Tools, Evaluation Methods, Online Course Evaluation, Development Methods Evaluation

Resumen

La evaluación de productos instruccionales ha sido reconocida como una actividad esencial de todo proceso enseñanza – aprendizaje. Los productos instruccionales, tales como cursos en línea, programas de entrenamiento, tutoriales, módulos instruccionales, gestión de cursos en línea, guías de estudio Web y métodos para desarrollar y evaluar productos instruccionales, deben ser evaluados durante su desarrollo, uso o al final del proceso de aprendizaje. La evaluación de un producto instruccional es un proceso complejo. Demanda el uso de recursos, tales como personas, herramientas, métodos y tiempo, los cuales deben ser planeados y controlados de la mejor manera, buscando asegurar la eficiencia y efectividad de dicho proceso. En este artículo, describimos un método, dirigido a educadores, profesores y diseñadores instruccionales, que guía el proceso de evaluación de un producto instruccional. El método propuesto, intenta resolver algunos de los principales problemas asociados a los métodos de evaluación existentes. Entre algunos de los problemas están la dificultad de adaptación a necesidades particulares y la ausencia de actividades gerenciales como parte del proceso de evaluación. Debido a que su definición sigue principios básicos de la ingeniería de métodos y de software, nuestro método es general, completo, estructurado, adaptable e independiente de técnicas y productos particulares. El método está compuesto por tres modelos: modelo de proceso, modelo de producto y modelo de grupo de trabajo. Estos tres modelos han sido integrados con el objeto de guiar de manera efectiva el proceso de evaluación de productos instruccionales. El método, por sí mismo, es un marco general de referencia que puede ser fácilmente adaptado para evaluar una amplia variedad de productos instruccionales, siendo esta su principal contribución al proceso de enseñanza-aprendizaje.

Palabras claves: Educación a distancia, Herramientas y ambientes de apoyo a la enseñanza, Evaluación instruccional, Métodos de evaluación, Evaluación de cursos en línea, Evaluación de métodos de desarrollo

* Publicado en las Actas del X Congreso Iberoamericano de Educación Superior en Computación (XCIESC), Montevideo, Uruguay, 2002.

1 Introduction

In the educational context, an instructional product is a material or artifact that may be used in a teaching-learning process. Most of the instructional products can be classified into one of the following categories: instructional modules, online courses, training programs, instructional multimedia applications (tutorials, simulations, educational games, intelligent tutorials system, drill and practices, virtual reality modules), instructional interactive videodisc, course management systems, study guides, videotapes, teaching tele-courses, computer based instruction, workbooks, and textbooks. Tools and methods for developing and/or evaluating instructional products are also considered instructional products.

It is necessary to evaluate how well an instructional product does what it is supposed to do. The development process of the instructional product must be evaluated too. The evaluation of instructional products is a process whose main objective is to judge the effectiveness of the products and assess their properties. What to measure and how to measure are recognized as processes that require careful thought and highly specialized skills [1].

Several methods for evaluating instructional products have been published in the literature. However, there are, at least, three problems associated to these evaluation methods. First, all of them focus on the evaluation of specific types of instructional products. The methods described in [2], [3], [4], and [5], for instance, deal only with the evaluation of online courses. The IQ Pilot Project, developed by the Texas Education Agency [6], presents three domains for evaluating online courses: course components, support and financial components. Hazari [7] describes a methodology for evaluating and selecting web courses development tools. These methods cannot be used to evaluate a different type of instructional product.

Secondly, most of these methods are based on a particular evaluation approach, technique or theory that forces the evaluation teams to assess only a fixed number of aspects or properties of the instructional product. The method described in [1], for example, evaluates multimedia-based courses using the Kirkpatrick's four levels of evaluation (reaction, learning, behavior, and results) and the application of statistical testing techniques. Similarly, the evaluation procedure described in [3] evaluates only three aspects of an online course: student performance, course effectiveness, and software tools. The Michigan Virtual University [2], in particular, focuses on four different evaluation categories: technology, usability, accessibility, and instructional design. On the other hand, the North American Association for Environmental Education [8] presents six key characteristics for creating effective environmental education materials: fairness and accuracy; depth; emphasis on skills building; action orientation; instructional soundness; and usability. These indicators suggest ways of measuring whether the materials have being evaluated or developed following their guidelines. Gorski [9] incorporates new criteria to the general educational product evaluation that examine the multicultural-educational meaning of individual Web sites. It focuses on assessing the level to which educational Web sites utilize the multicultural potentialities of Internet. The problem of all these methods is that they preclude the generality of the evaluation methods, because different approaches, techniques and additional levels of evaluation cannot be easily added to the methods.

Thirdly, the majority of the methods mentioned above do not include management activities to deal with the processes of planning, organizing, directing, quality assurance, and controlling the evaluation project. An exception is the Lee and Owen's method [1] which includes specific tasks for managing the evaluation process.

The need for a more general, complete, adaptable, and technique independent evaluation method is, therefore, well justified. We describe, in this paper, an evaluation method for guiding educators, teachers, and instructional designers to evaluate different types of instructional products. The proposed method intends to solve the three problems that were identified above. The design of the method was based on principles and concepts taken from Method Engineering [10], [11], [12]. One of these principles establishes that a method should have a purpose that specifies its domain, the kind of problems to be solved, and the conditions or restrictions to use it. Another important principle establishes that a well-defined method should be described in terms of two components: a model of the product to be evaluated and a process model that explain how to evaluate the product. The structure of the method is based on well-known software engineering practices, models and notations that have proved to be very useful in developing methods. For instance, the product and process models of the evaluation method are expressed using the UML language [13] and the IDEF0 notations, which are two standards for object-oriented software modeling.

The paper is organized as follows. In section 2, we present the evaluation model and describe its three components: the team model, the product model, and the process model. The process of instantiating or using the method is described in Section 3. We use the evaluation of instructional web sites development methods as an example to explain in more detail the process model of the method. Concluding remarks about the method and its instantiation process are given in the final section.

2 The evaluation method

Method Engineering is defined as a systematic and coordinated approach to establishing work methods [12]. A method defines the activities needed to create, design, develop or evaluate a product. These activities, along with the techniques and tools needed to execute them, are described by a formal, textual or graphical representation, known as the *process model*. A generic representation of the products to be designed, developed or evaluated is also required to have an anticipated understanding of the process model. This representation is called the *product model*. It describes the concepts and their interrelationships that are common to all products of the type addressed by the method.

Method Engineering concepts allowed us to build a two level abstraction hierarchy for evaluating instructional products (see Figure 1). In the upper level, there are the three models proposed by our method: a team model, a measurement instrument model, and a process model. The *team model* is a description of the roles played by the participants of the evaluation process. The *measurement instrument model* is the main component of the product model of the method. It describes the concepts and structure used to design instruments for evaluating instructional products. The *process model* describes the activities that the evaluation team should follow to evaluate an instructional product. Each of these models is described, in more detail, in subsections 2.1 – 2.3.

At the lower level, there are the instantiations of each one of the models that correspond to the evaluation of a particular instructional product. An instantiation is the result of adapting the concepts described by the model to those particular situations derived from the characteristics of an instructional product being evaluated. For instance, the measurement instrument designed for an online course differs from other designed to evaluate a tutorial. Both have the same concepts expressed by the measurement instrument model. However, they differ in the values associated to these concepts and the domains in which those concepts were defined.

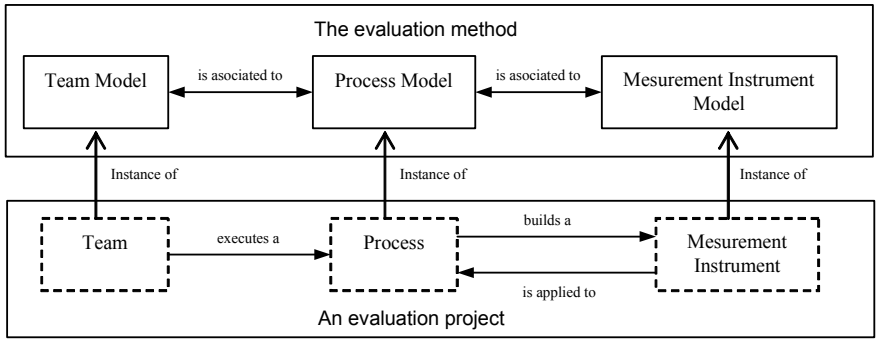

Figure 1. Levels of abstraction for evaluating instructional products

2.1 The team model

An important aspect of the evaluation process is the organization of the effort that will be required to evaluate instructional products. We will refer to the group of people that participates in the evaluation process as the *evaluation team*. An evaluation team can be organized in many different ways depending on the complexity of the instructional product to be evaluated. In figure 2, we propose an organizational structure composed of an *evaluation leader*, one or more *evaluation designers*, one or more *evaluation administrators*, and a group of *evaluators*.

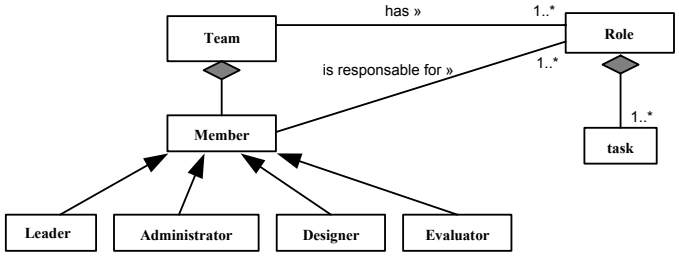

Figure 2. The team model

The evaluation leader is responsible for planning, organizing, directing, supervising, and controlling the whole evaluation process. The evaluation designers are in charge of the requirements definition, the evaluation instruments

design, and the production of these instruments. The evaluation administrators are in charge of conducting the tests and analyzing the data obtained during the evaluation administration. The evaluators are the group of users, students, instructors, mentors, instructional designers, etc., that will use the evaluation instruments to assess the instructional products.

2.2 The measurement instrument model

The design of evaluation instruments is the most complex and demanding activity of the evaluation of an instructional product. It requires focusing the attention on those aspects, components and properties of an instructional product that are relevant to the evaluation objectives. The design of an evaluation instrument requires the use of a model that helps the designer to create the instrument. This model, called the measurement instrument model, is shown in Figure 3. It describes the concepts and structure that are generally present in all the evaluation instruments to be developed using our method. It may be seen as a template or pattern that evaluation designers use to sketch the structure of measurement instruments. By using the measurement instrument model, the evaluation designers know exactly how to structure an evaluation instrument.

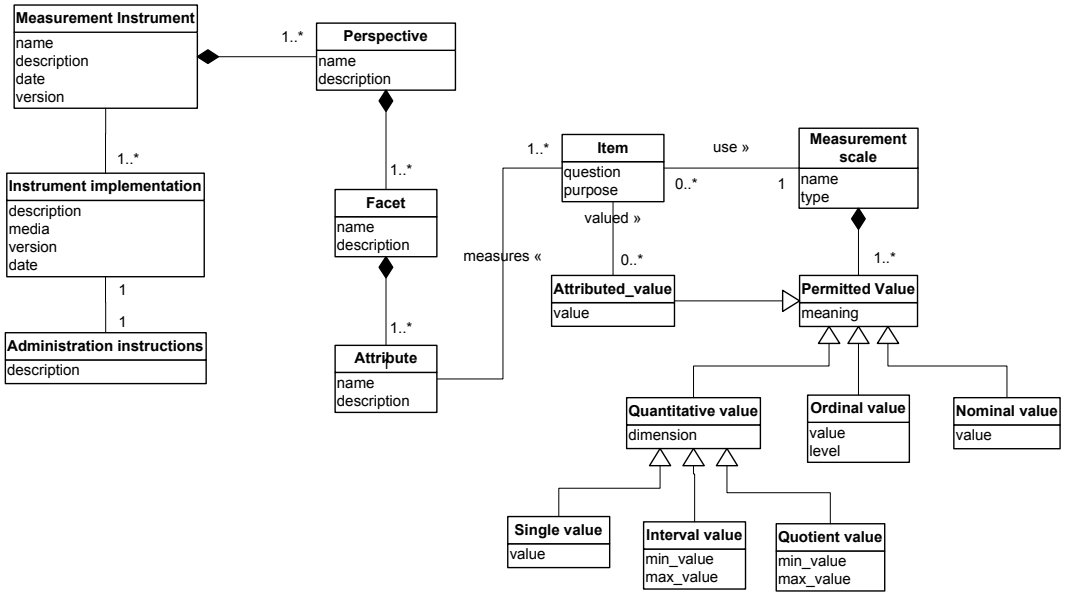

Figure 3. The measurement instrument model for evaluating instructional products

The interpretation of the measurement instrument model is as follows. An instructional product can be assessed from different views or perspectives (see Figure 4). An *evaluation perspective* is a viewpoint or position from which the evaluation team assesses the product. For each evaluation perspective, the evaluation team identifies the features of the product that are relevant to the evaluation objectives. The selected features to be evaluated, from a given perspective, are called *facets*. In Figure 4, for instance, the evaluation perspective *2* has associated a set of *m* facets (*F2.1 – F2.m*). A facet is composed of a collection of *attributes*. Each attribute describes a particular property or characteristic of the instructional product that the evaluation team has decided to assess.

Let us illustrate this decomposition process through an example that consists of the evaluation of online courses. An online course can be evaluated from several perspectives, such as instructional, technological, structural, and functional perspectives. The instructional perspective may define different facets, such as the course content, the instructor, the learning environment, and the instructional program to which the course belongs. The *instructor facet* may be structured into the following attributes: teaching experience, teaching effectiveness, computer proficiency, subject-matter knowledge, ability to motivate students, etc.

An attribute may be described by a collection of one or more *items*. Items are the building blocks of a measurement instrument. They are the questions or queries that allow the evaluator to measure the value(s) associated to an attribute. Each item has associated a *measurement scale* that defines all the possible values that can be assigned to that item by the evaluators. A measurement scale is, therefore, a collection of *permitted values* used to assess an attribute. An *attributed value* is a value that an evaluator will assign to the corresponding item at the time that the test is conducted. There are, at least, three types of measurement scales that can be applied for evaluating

instructional products: *nominal, ordinal,* and *quantitative* [14], [15].

A nominal scale uses qualitative values based on names or words that assess a property of the instructional product. For example, the attribute *education level* of the facet *course* can have associated the following scale or set of nominal values {1: *high school; 2: undergraduate; 3: graduate; 4: adult education*}.

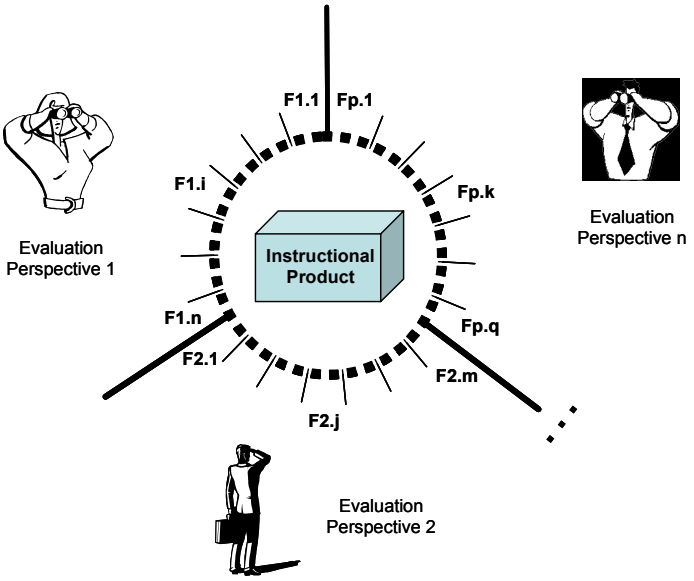

Figure 4. Evaluation perspectives of an instructional product

Ordinal scales use also quantitative values, but they establish an order or hierarchy between the set of values. In the facet *instructor*, for instance, the attribute *ability to motivate students* can have associated the following set of ordinal values: {*1: low; 2: moderate; 3: high*}. The so-called Likert scale is a type of ordinal scale whose values are: {1: very poor; 2: poor; 3: average; 4: good; 5: very good}.

Quantitative scales are made of numerical values. A quantitative scale has two elements: a magnitude and a dimension. The magnitude is the numerical value itself. The dimension, on the other hand, is the meaning of that value. For example, the item "*what was the number of students in the course?*" can have associated a set of integer positive values. If the number of students in that course was *30*, then the number *30* is the magnitude of the value and *students* is the dimension of that value.

A quantitative scale can be made of single values, interval values, or quotient values. A single scale has associated a set of single numerical values, as illustrated by the previous example. An interval scale has assigned a set of intervals. For example, the item "*In average, how many hours per week did you spend navigating in the course site?*" may have the following set of interval values: {[0-5], [6-10], [10-15], [16, or more]}. Finally, the ordinal scale has a set of quantitative values that have an origin value *zero* (*0*) that express the total absence of the property denoted by the scale. For example, the item "*How many years of teaching experience do you have in the course subject?*" may have an ordinal scale of integer values starting at zero to indicate the absence of teaching experience.

Table 1 shows the partial structure and content of an instrument for evaluating course sites that was designed using the measurement instrument model.

Table 1. An example of a measurement instrument structure and content

Perspectives	Facets	Attributes	Items	Measurement Scale (permitted values)
Instructional	Instructor	Teaching experience	How many years of experience does the instructor have teaching the course?	{[0-5], [6-10], [10-15], [16 or more]}
		Teaching effectiveness	The instructor effectiveness in teaching the course was:	{1: very poor; 2: poor; 3: average; 4: good; 5: very good}
	Course	Course objectives	Were the course objectives clearly stated or explained?	{no, yes}
			Were the objectives consistent with the course content?	{ 1: never; 2: more less; 3: always }
Technological	Web site usability	Visibility of course site status	Does the course site always keep you informed about what is going on?	{ 1: never; 2: more less; 3: always }
		Help and documentation	The help information provided by the course site is:	{excellent, very good, good, fair, poor, very poor}
			Does the course site have an online manual document?	{yes, no}

2.3 The process model

The process model of our evaluation method describes the activities to be performed by the evaluation team in order to assess an instrument product. This model is composed of two types of parallel and complementary processes (see Figure 5). The first of them, called the *management process*, is concerned with the activities that are required to manage the project of evaluating an instructional product. The evaluation leader is responsible for the execution of these managerial activities (M1 – M5). The second one, called the *evaluation process*, is related to the phases that are needed to define the evaluation requirements, design and produce the measurement instruments, conduct the tests and analyze the results. The phases of the evaluation process (E1 – E6) are executed by the other members of the evaluation team.

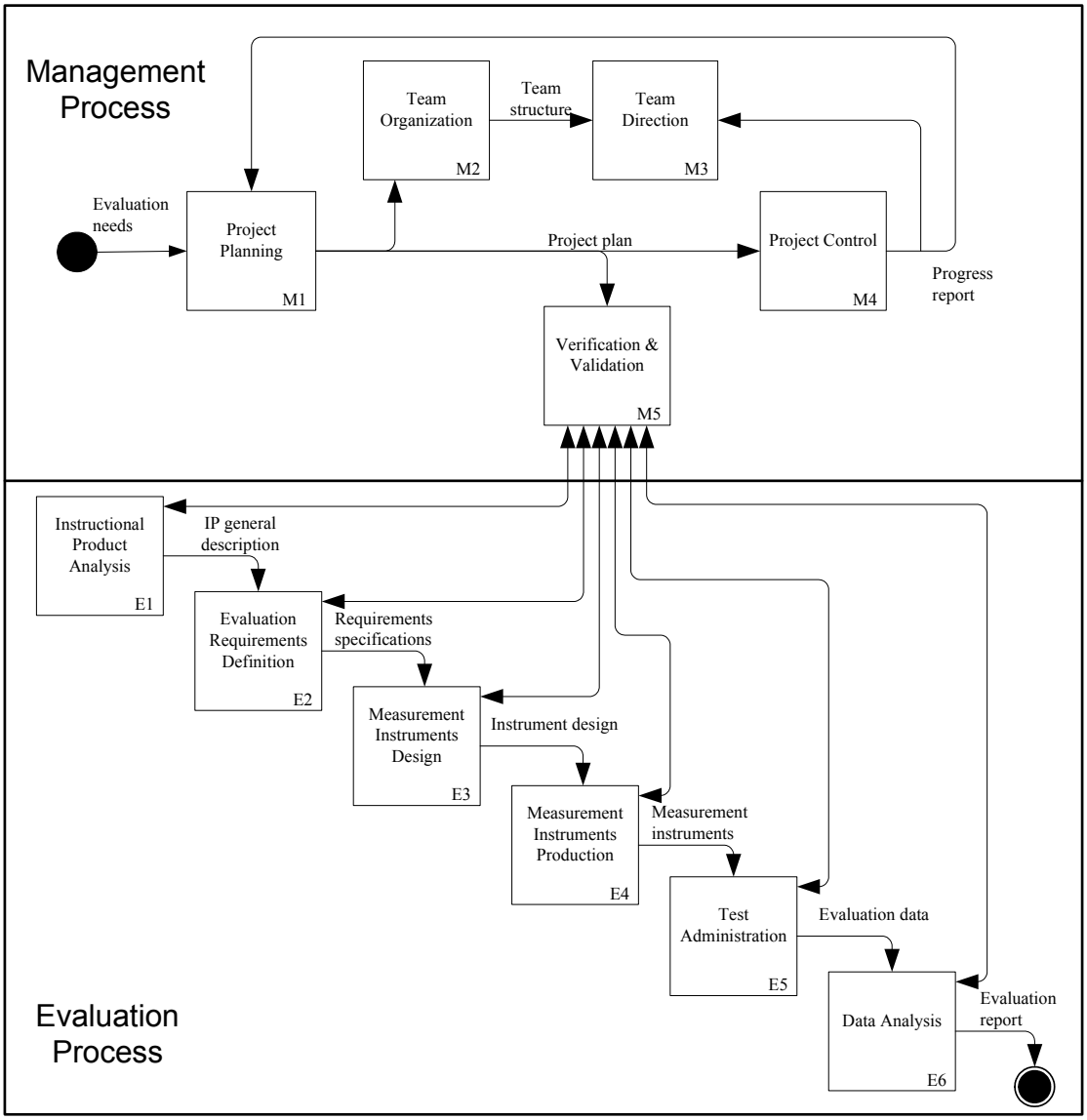

Figure 5. The structure and workflow of the process model

Figure 5 also shows the workflow of the method. The application of the method starts at the Project Planning activity (M1) and continues through the Team Organization activity (M2). Once the team is organized, the Evaluation Process can be initiated by executing the phases E1 to E6 in sequential order. The deliverables produced by the evaluation phases (E1 – E6) are reviewed by the Verification & Validation activity (M5), which ensures the quality of the deliverables and determines if the evaluation team can advance to the following evaluation activity. The effort and performance of the evaluation team is supervised and coordinated by the evaluation leader through the Team Direction activity (M3). The management and evaluation activities are monitored and controlled by evaluation leader following the Project Control activity (M4).

2.3.1 The management process

The management process is hierarchically structured into activities and sub-activities, as shown in Table 2. The activities produce one or more deliverables that are the results of applying selected managerial techniques and tools. In this context, a deliverable is an internal document produced by the evaluation leader to manage the evaluation project. It should be noted that all the deliverables are also components of the product model. In section 2.2, we omitted the description of these components for space reasons.

Table 2. The management process

Activities	Sub-activity	Techniques and tools	Deliverables
Project Management	Project Planning (M1)	Project management techniques (e.g., PERT, CPM) Project management tool (e.g. MS Project™)	Project plan Team structure Roles description Control diagrams
	Team Organization (M2)	Organizational structures Job description	
	Team Direction (M3)	Motivation Supervision Coordination	
	Project Control (M4)	Project control techniques (e.g., PERT, CPM)	
Quality Assurance	Verification and Validation - V&V – (M5)	Technical reviews (e.g., Design Inspections)	Checklist

Project Planning and Control: Project planning is the first managerial activity of the evaluation process. Its output is a project plan that contains a schedule and a budget. The schedule defines the timing and order of the activities to be executed by the evaluation team. The budget estimates the cost of the evaluation project. Project control is tied to the project planning activity. It monitors the progress of the project, compares this progress with the project plan, and provides the feedback needed to update the plan.

Team Organization and Direction: The objective of the Team Organization activity is to define the structure and responsibilities of the evaluation team. In section 2.1, we describe a team model that can be used for evaluating most instructional products. However, factors such as the scope and size of the instructional product, the budget assigned to the project, the time restrictions, and the availability of specialists may influence the decision of structuring the team in a different manner. Moore and Kearley [16] discuss different team structures that can also be applied to organize evaluation teams. Team Direction is another essential managerial activity that is closely related to the organization of the team. Keeping a high level of motivation among the team members and an appropriate coordination and supervision of the activities are important direction activities to be developed by the evaluation leader.

Quality Assurance: Ensuring the quality of the evaluation products is a major aspect to be considered in an evaluation project. The quality of the deliverables is ensured through the execution of two related activities: verification and validation. These two complementary activities ensure, for instance, that the measurement instruments comply with the evaluation requirements. The verification and validation of a deliverable is achieved by using technical reviews, such as design inspections and walkthroughs [17]. A technical review is conducted by the evaluation leader at the end of each evaluation phase. These reviews also determines if the evaluation team can advance to the next phase or must go back to the previous phase to incorporate new changes or correct errors detected in the deliverables.

2.3.2 The evaluation process

The evaluation process is composed of six phases. Each phase is divided into steps that are executed by the members of the evaluation team. The execution of the phases produces deliverables. Some the deliverables are intermediate products that are required to advance to the next phase. The roles to be played by the members of the evaluation team in each phase, as well as the decomposition of phases into steps, and their deliverables are summarized in Table 3.

Table 3. The evaluation process and products

Phases	Steps	Team roles	Deliverables
Instructional Product Analysis (E1)	Analyzing the instructional product	Evaluation designers	Instructional product general description
	Analyzing the instructional product domain		
Evaluation Requirements Definition (E2)	Defining the evaluation objectives	Evaluation designers	Requirements specification
	Defining the evaluation requirements		
	Defining the evaluation quality attributes		
Measurement Instruments Design (E3)	Determining the number of instruments to be applied	Evaluation designers	Instrument design
	Designing the structures of the measurement instruments		
	Designing the contents of measurement instruments		
Measurement Instrument Production (E4)	Deciding the instrument implementation media	Evaluation designers	Measurement instruments
	Elaborating the measurement instruments		
	Elaborating the test administration instructions		
Test Administration (E5)	Selecting the evaluators	Evaluation administrators	Evaluation data
	Training the evaluators		
	Conducting the test	Evaluators	
Data analysis (E6)	Analyzing the data collected through the instruments	Evaluation designers Evaluation leader Evaluation administrators	Evaluation report
	Writing the evaluation report		

3 Applying the method

To illustrate the application of our method, we use a study case that consists of the evaluation of three course site development methods. These methods are the Instructional Web Site Development Method of Montilva, Sandia, and Barrios [18], the Multimedia-based Instructional Design Method of Lee and Owens [1] and the On-line Course Development Method of Schweizer [5]. The availability and completeness of the method documentation were the main criteria used for choosing them. For convenience, we will refer to these methods as A, B, and C, respectively.

For space reasons, we describe only those phases and steps of the evaluation process model that are critical to understand the application of the method. In the description of the phases we have to omit many details, such as the intermediate deliverables produced in many of the phases. We concentrate in the main product: the measurement instruments. The activities of the management process (M1 – M5) are also omitted. They were already explained in section 2.3.1.

3.1 The Instructional Product Analysis (E1)

The purpose of this phase is to get an understanding of the instructional product before initiating its evaluation. The analysis of the instructional product is crucial for understanding the scope and purpose of the evaluation. The evaluation designers must define, in this phase, the objectives, the application domain, and the general components of the instructional product.

In our case, the analysis of methods A, B, and C did not intend to describe each product in detail, but to acquire a general understanding of them as a class or group. This understanding helped us to determine what aspects of the evaluated methods were relevant to the evaluation. These methods are instructional products whose main objective is to guide instructors, web site developers, and instructional design experts during the process of developing course sites. A course site is a teaching-learning environment implemented and delivered through WWW to support an online course. It is a special kind of software application that is created and maintained using either a general-purpose web editor or a specialized course management system. The application domain of the methods is, therefore, the development of online courses.

The general components of the methods were defined from a method engineering point of view. From this view, a well-designed course site development method is composed of, at least, a product model and a process model. The product model is an abstraction of the properties that are commonly ascribed to any of the course sites to be developed. It represents, using a graphical or formal notation, the set of general concepts that are needed to build a course site. The process model, on the other hand, specifies the set of activities required to develop a course site according to the product model. A description of the roles to be played by the development team is also a desirable component of a development method.

Additional properties of the methods, which were identified in this phase, are the following. A method to develop course sites must take into account different aspects of the product, including its instructional, structural, functional, and aesthetical properties. It must allow the development team to deal with the complexity of the process. It must make clear and visible the structure of the development process. A set of guidelines or explicit activities for managing the projects are also important. Managerial activities deal with the processes of planning and controlling the project, ensuring the quality of the course site, and controlling the time, effort, and resources required by the development project.

3.2 The evaluation requirements definition (E2)

The goal of this phase is to elicit and describe the objectives and requirements of the evaluation project. It must answer questions such as: what is the scope of the evaluation; why the evaluation of the product is needed; who will be benefited from the evaluation results; what aspects or features of the instructional product are more critical or important to the evaluation; what resources (e.g., people, time, money, and tools) are available to carry out the evaluation; and what attributes must be considered to ensure the quality of the measurement instruments.

In our example, the objective of the evaluation was to compare methods A, B, and C in order to highlight the strengths and weaknesses of them. Our main interest, in this evaluation, was to show the benefits and limitations of method A, which is explained in [18]. Instead of evaluating method A separately, we opted for evaluating it by comparison to others methods available at the literature. A limited set of financial and human resources were available to conduct the evaluation. A group of three experts with different backgrounds in software engineering and instructional design was available. As attributes to verify the quality of the measurement instruments, we chose the following: completeness, clarity, and separation of managerial and technical aspects or concerns.

3.3 The measurement instruments design and production (E3 – E4)

The product model described in section 2.2 must be used, in this phase, to design the measurement instruments that the evaluation team requires to assess the instructional product. In this phase, the evaluation designers must decide on the number of instruments to be produced and the evaluation approaches (techniques, theories, styles or principles) to be applied in the design of these instruments. The designers must then identify and define the perspectives for evaluating the product. Each perspective must be divided into a set of facets that describes different features of the product being evaluated. Each facet is, in turn, divided into a set of attributes that describes the most relevant variables or properties of the product.

The measurement instruments may be produced in many different formats and media. WWW is actually the preferred media used to evaluate instructional products. The ability to reach the evaluators without location and time constraints makes web-based instruments the preferred format. Alternative formats and media include paper-based forms, multimedia forms, and spreadsheets.

In the evaluation of methods A, B, and C, we identified four perspectives that are grounded on the principles established by Method Engineering, as stated in [11]. These perspectives allowed us to assess the most important features of a development method: its application domain, its usage, its product model, and its process model. The perspectives are briefly described next for illustration purposes.

- The *Domain Perspective* is related to the application domain of the methods being compared. It is described by two facets: the *scope* facet and the *instructional* facet. The scope facet allows the evaluators to appraise the methods according to their coverage of technical, instructional and management features, and its application area. The *instructional* facet is concerned with the educational features of the web sites developed by the methods. It includes the educational level, the instructional modality, the type of course to be developed, and the dependence of the methods on specific instructional approaches.
- The *Usage Perspective* is concerned with the applicability and usability properties of the methods. These properties are captured by the facets: applicability, usability, and user involvement. The *applicability* facet evaluates the phases of the web site life cycles covered by the methods, as well as the main uses of them. The *usability* facet describes the usage characteristics of the methods. The *user involvement* facet specifies the expected type of users and their participation in the course site development process.
- The *Process Model Perspective* evaluates the product models used by the methods. Two facets were chosen to describe the product models. The *product representation* facet characterizes the product model availability, its orientation, the notation used to describe it, and the set of perspectives or points of view used to typify the product. The *conceptual description* facet is concerned with the types of concepts used by the models that are explicitly stated in the method documentation.
- The *Process Model Perspective* is associated to the evaluation of the process models of the methods. It

contains the set of facets and attributes that evaluates the features and properties of the process models used by the methods. Five facets were defined to evaluate the following features of the process models: their orientation or approach, their main characteristics, their management process, their development process, and their post-development process.

A measurement instrument was designed for each perspective. The four instruments were produced using a spreadsheet tool. To exemplify the results of this phase, we show in Table 4 the instrument used to evaluate the methods from the usage perspective. The other instruments are given in [18]. We chose a unique measurement scale based on nominal values, because of the simplicity and clarity that they provide during the data analysis phase. The set of permitted values associated to the measurement scale is the following:

{√: Present; ~: Not clearly specified in the documentation; (blank): Not present}.

Table 4. A measurement instrument example

Facet	Attributes	Items	Method A	Method B	Method C
Applicability	Life cycle completeness	Analysis	√	√	√
		Design	√	√	√
		Development	√	√	√
		Evaluation	√	√	√
		Maintenance		√	
	Main use	Academic	√	√	√
		Company training		√	
Usability	Visibility	Always shows what to do	√	√	√
		Always shows how to do it	√	√	
	Use of standards	Use of standard techniques	√		
		Use of standard notations	√		
	Flexibility and efficiency of use	Adaptable and expandable	√		
		Simple and easy to use	√		√
		Well documented	√	√	√
User involvement	Expected user type	Instructor/teacher	√	√	~
		Software developer/manager	√	√	
		Instructional designer	√	√	
	User participation	All phases	√		√
		Selected phases only			
		No participation		√	

3.4 The tests administration (E5)

The tests can be administered once that the measurement instruments are produced and documented. This phase involves three steps. The first one consists on the selection of the evaluators, that is, the group of people that will use the instruments to assess the instructional product. The second step is to train the evaluators to guarantee the appropriate usage of the instruments. This can be achieved by explaining to the evaluators the instructions or procedures that are elaborated in phase E4. The third step is to conduct the tests following the mentioned procedures.

3.5 The data analysis (E6)

The final phase of the method is the analysis of the data obtained during the tests administration. This analysis is perhaps the most difficult activity of the method. All members of the evaluation team should participate in this activity. An evaluation report that summarizes the conclusions of the analysis must be written by the evaluation leader.

The following paragraphs, borrowed from [18], illustrate the data analysis of methods A, B, and C from a usage perspective.

"The three methods cover the most important stages of the course site life cycle (analysis, design, development and evaluation). However, the ways they evaluate course sites differ notably. Method A evaluates the product during the development process. Method B evaluates the product at the end of the development process. Method C, on the other hand, evaluates the site at the end of the course. Evaluating the product during its development has several advantages. Firstly, the drawbacks and faults of the course site can be detected and corrected before it is delivered. Secondly, development costs and time can be reduced drastically since the course site requirements are verified and validated at the end of each development phase.

Usability is a major concern for selecting a method. Methods A and B make the development process highly visible, since they provide detailed guidelines to the development team, not only on what to do but on how to do

each activity of the process. Method A is more adaptable, simple and easy to use than B. This is due to the modularity of its process model and the proper use of standards and well-known techniques and notations."

4 Discussion

This study has showed the usefulness of our proposition as a methodological tool for evaluating instructional products. The study case has demonstrated the most important characteristics of our method: generality, completeness, modularity, adaptability and technique independence. The evaluation team may use any theory, technique or approach that they judge to be the most convenient for a particular evaluation project as well as modifying and adapting components and modules according to the characteristics of the instructional product being evaluated.

The main contribution of our method to the teaching-learning process is that it provides a general evaluation framework that can be adapted to special instructional product requirements. It solves the three principal problems detected in current evaluation methods and approaches. This method guides two types of processes, the process of designing a measurement instrument and the process of applying it, once it has been designed. The method is composed of three complementary models that satisfy the primary needs of an evaluation process. It has an activity oriented *process mode*l for guiding users either for designing a particular measurement instrument and applying it, and a *product model* that describes the main concepts that must be present in any measurement instrument. The product model also describes the products or deliverables related to the activities of project management. The *team model* complements the set of models permitting to organize team members according to their experience and capabilities. The responsibilities of each one of the team members are prescribed entirely in the process model. Its execution allows them either to design an evaluation instrument or to apply it.

Our method has a restriction: the process of adaptation of the proposed framework, which is characterized by the definition of perspectives, facets and attributes, is strongly dependant on the team experience and their capacity of capturing specific evaluation requirements. Future work will be concentrated in the extension of the approach by adding strategies and guidelines to support evaluators during the process of characterizing particular needs of an evaluation process. This support shall be presented as a detailed set of directives that guides more accurate decisions about what is a perspective, how it should be defined, what are the facets that characterize it and what are the set of attributes that should be measured. Besides, the method requires further evaluation in order to validate its effectiveness and compare our method with others reviewed in the literature.

Acknowledgements

This research has been sponsored by FONACIT - the Venezuelan national research council - under project No. G-97000823.

References

[1] Lee, W. L. and Owens, D. L. (2000) *Multimedia-Based Instructional Design*. Jossey-Bass Pfeiffer, San Francisco.

[2] Michigan Virtual University (2002). *Quality Online Courses.* [On line] http://www.ideos.net/standards/

[3] Pallof, R.M. and Pratt, K. (1999) *Building Learning Communities in Cyberspace*. Jossey-Bass Publishers, San Francisco.

[4] O'Sullivan, M. F. (1999) Worlds within Which We Teach: Issues for Designing World Wide Web Course Material. *Technical Communication Quarterly*, **8**(1), 61--72.

[5] Schweizer, H. (1999) *Designing and Teaching an On-Line Course*. Allyn & Bacon, Boston.

[6] Texas Education Agency (2001). *Quality of service guideline for online courses.* [On line] http://www.iqstandards.info

[7] Hazari, S. I. (1998). *Evaluation and selection of web course management tools.* [On line] http://sunil.umd.edu/webct

[8] North American Association for Environmental Education (2000). *Environmental Education Materials: Guidelines for Excellence - The Workbook.* [On line] http://naaee.org/npeee/materials.html

[9] Gorski, P. (1999). *Toward a Multicultural Approach for Evaluating Educational Web Sites.* [On line] http://curry.edschool.virginia.edu/go/multicultural/net/comps/eval.html

[10] Brinkkemper, S. (1996) Method engineering: Engineering of information systems development methods and tools. *Information and Software Technology*, **38**, 275--280.

[11] Barrios, J.(2001) Une Méthode pour la Définition de l'Impact Organisationnel du Changement. (2001). Ph.D. thesis. University of Paris I.

[12] Odell, J.J. (1996) A Primer to Method Engineering. INFOSYS: The electronic newsletter for information systems. Vol 3, Number 19,. Denis Viehland, Massey University, New Zealand.

[13] Booch, G., Jacobson, I. and Rumbaugh, J. (1998) *The Unified Modeling Language User Guide*. Addison Wesley, Reading.

[14] Puleo, F. (1985) Paradigmas de la Información (in Spanish). Consejo de Publicaciones de la Universidad de Los Andes. Mérida, Venezuela.

[15] Flores, E. J. (1997) Introducción al Conocimiento del Sistema Diagramático (in Spanish). Consejo de Publicaciones de la Universidad de Los Andes. Mérida, Venezuela.

[16] Moore, M.G. and Kearsley, G. (1996) *Distance Education: A Systems View*. Wadsworth Publishing Company, Belmont.

[17] Ince, D., Sharp, H. and Woodman, M. (1993) *Introduction to Software Project Management and Quality Assurance.* McGraw-Hill. London.

[18] Montilva, J, Sandia, B., and Barrios, J. (2002) Developing Instructional Web Sites - A Software Engineering Approach. To appear in *Education and Information Technologies Journal*, Kluwer Academic Publishers.