Chapter 2
Emergent Evaluation Criteria for Collaborative Learning Environment

Ibrahiem M.M. El Emary

Information Technology Deanship, King Abdulaziz University, Jeddah,
Kingdom of Saudi Arabia, omary57@hotmail.com

Abstract System and software architecture evaluation techniques have advanced significantly within last decades, but little progress has been made in the development of formalized methods and tools for distributed-collaborative architectural evaluation. Collaborative evaluation represents an effective professional development method to the degree that it sustains argumentation about the application of evidence-based design principles. The main objective of this chapter is to address an effective educational support environment and to develop meaningful collaboration learning applications. It is used for learners of educational multimedia to help them develop understanding, knowledge, and confidence and to promote the effective use of multimedia in supporting teaching and learning. This system is a framework supporting collaboration work using computers and communication vendors in a geographically distributed ubiquitous environment.

Keywords Architecture • Evaluation • Collaborative evaluation • CEVE • VE • CVE

2.1 Introduction

In the past few years and due to the evolving growth in networking and telecommunication technologies, a number of interactive virtual environments (VEs) have been developed. VEs from typical software applications can be defined as interactive, multisensory, three-dimensional, computer-synthesized environments [1]. Three-dimensional (3D) VEs come with varying features; however, typically, most provide three main components: the illusion of 3D space, avatars that serve as the visual representation of users, and an interactive chat environment for users to communicate with one another. Specific types of VEs can be distinguished based on their use or purpose. A collaborative virtual environment (CVE) is a computer-based, distributed, VE or set of places. In such places, people can meet and interact with others, with agents, or with virtual objects. CVEs are powerful and engaging

A.A. Lazakidou (ed.), *Virtual Communities, Social Networks and Collaboration*, Annals of Information Systems 15, DOI 10.1007/978-1-4614-3634-8_2,

collaborative environments for e-learning because they are capable of supporting several important learning objectives. These objectives include experiential learning, simulation-based learning, inquiry-based learning, guided exploratory learning, community-based learning, and collaborative learning (CL). It is probable that CVEs will play an important role in future education due to continuous enhancements in computer technology and the current widespread computer literacy among the public. To keep up with such expectations, e-learning systems have gone through a radical change from the initial text-based environments to more stimulating multimedia systems.

There are several reasons why producing high-quality multimedia learning resources is challenging. Many types of media, media features, and design models are available to resource developers, yet there are few standards that can guide in selecting them. Relevant research on multimedia learning has expanded, yet many developers are unaware of its full scope and value. Personnel are available who specialize in media development, instructional design, usability design, subject knowledge, and teaching, yet they are rarely coordinated so that their expertise can be effectively brought to bear. Learners usually have opinions about the resources they use, yet their opinions are rarely heard by developers. In most recent times, ubiquitous learning is characterized by providing intuitive ways for identifying right collaborators [2], right contents, and right services in the right place at the right time based on learners' surrounding context such as where and when the learners have time and space, what the learning resources and services available for the learners, and who are the learning collaborators that match the learners' needs. As a result, the effectiveness and efficiency of ubiquitous learning heavily relies on the surrounding context of learners.

Collaboration in virtual learning communities characterizes itself by heavily relying on interaction among the collaborators. The collaborators can be instructors and learners; the interaction can be resources discovery, access, and sharing, as well as group communication and discussion, or simply any collaboration which has occurred among the instructors and learners [3]. In addition, the collaboration should be enacted inside and outside of classrooms without limitation of space and time; it can be over the Internet and beyond the geographical boundary. Nevertheless, such collaboration environment is generally not supported by conventional learning environments. Typical learning services for collaboration in virtual learning communities are content, access of certain learning subjects, making studying notes and annotation on learning subjects, group discussion, brainstorming for knowledge creation, and sharing. This makes peer-to-peer network particularly suitable for implementing ubiquitous learning environments for collaborative learning.

Collaborative learning is an educational approach to teaching and learning that involves groups of students working together to solve a problem, complete a task, or create a product. Collaborative learning is based on the idea that learning is a naturally social act in which the learners talk among themselves [4]. It is through the talk that learning occurs. A set of assumptions about the learning process is described below: Learning is an active process whereby students assimilate the information and relate this new knowledge to a framework of prior knowledge. Learning requires a challenge that opens the door for the learner to actively engage his/her peers and to process and synthesize information rather than simply memorize and regurgitate it. Learners benefit when exposed to diverse viewpoints from people with varied backgrounds. Learning flourishes in a social environment where conversation between learners takes place. During this intellectual gymnastics, the learner creates a framework and meaning to the discourse [5]. In the collaborative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives, and are required to articulate and defend their ideas. In so doing, the learners begin to create their own unique conceptual frameworks and not rely solely on an expert's or a text's framework. The purpose of this collaboration is to bring interactive multimedia ubiquitous learning in real time.

As in any human computer interaction (HCI) research, educational technology designers use formative evaluation to informally understand what needs improvement in their learning environment, and guide the process of iterative design. Formative evaluation must pay attention first to usability and second to learning outcomes [6]. It is a qualitative approach, centered mostly on the operational requirements or the user requirements (learner-centered approach). Through formative evaluation, there is an assessment of the concepts and contents of the cognitive objects taught as well as of the supportive material.

According to Paramythis and Loidl-Reisinger [6], the types of formative evaluation are requirements estimation, structure definition, and development process and development fidelity. Furthermore, predictive evaluation can be part of the formative evaluation. It refers to the assessment of the quality and capabilities of the software, before its use by the target group. It is realized through means such as reports, reviews, and checklists. Expert heuristic and formative evaluations are applied in alternating cycles in the early design state of the CEVE [7]. Based on the expert's knowledge, problems concerning usability can be solved following the expert's recommendations. After these recommendations are considered in a new and better design of the CEVE, the summative evaluation is applied. The objective of the summative evaluation method is to compare different CEVEs designed with the information obtained from the User + Need Space and to determine the effectiveness of the software compared to predefined goals.

Another form of evaluation is interpretive evaluation. The main idea of this method is observation of the use of the educational software by the target group. It can be software-oriented, development-oriented, or concerning the evolving learning process through the use of the software. Bruce [7] suggested a framework constructed out of two different but complementary theoretical models: the conversational framework and the viable system model (VSM). The conversational framework is a well-known model of effective teaching practice for academic learning. The VSM is a model for the design and diagnosis of effective organizational structures drawn from management cybernetics. Bruce [7] presented a case study where place

Fig. 2.1 The definition of CEVEs

metaphors in a number of 3D educational CEVEs are analyzed. The methodology followed was based on an exploratory case study and concludes that a characterization framework of 3D CEVEs could be based on the terms of learner, place, and artifact. Even though this is not an evaluation framework, we believe that it could provide guidelines toward the determination of specific metrics in an evaluation framework for CEVEs (Fig. 2.1).

Another significant work concerning the way that virtual reality aids complex conceptual learning has been presented [7]. Although this work is focused on immersive VEs, it is possible to adopt the model's main ideas for scientific investigations concerning also other types of virtual environments such as desktop-based VEs [7]. According to this model, the first step is to specify the learning concepts and which of the VEs characteristics are able to facilitate the knowledge acquisition. The next step is to gather background information on the learners.

Finally, Henda and Mohamed [8] have also observed that there is a need for a detailed theoretical framework for VR-based learning environments that could guide future development efforts. They point out that a critical step toward achieving an informed design of a VR-based learning environment is the investigation of the relationship between the relevant constructs or participant factors, the learning process, and the learning outcomes. According to the above, we can conclude that there is no focused and concrete evaluation framework for evaluating CEVEs. One the one hand, there are many techniques and evaluation frameworks for evaluating either the pedagogical or the technical nature of CSCL systems, but none of them is focused on the CEVE nature of the e-learning system. One the other hand, there are several evaluation approaches for CEVE systems. However, none of them is focused both on the pedagogical and educational nature of the e-learning system.

2.2 System Configuration

This system is a framework supporting collaboration work using computers and communication vendors in a geographically distributed ubiquitous environment, as shown in [9]. The system is structured from various layers; the layer representation of the system architecture helps one to understand the scope of each service and the relationship with other services. The system architecture can be viewed as divided in four logical parts: the infrastructure, the service functions, the advanced service functions, and the application. The system infrastructure includes operating systems and communication service module which supports data transportation among PCs in distributed collaboration environment, creates/destroys the network connections, and performs the functions controlling the QOS by detaching the network load.

Service functions include session management, floor management, concurrency management, and media management. Also, the advanced service functions include creation/deletion of shared window and creation/deletion of video window. Shared window object provides free hand line, straight line, box, and text to collaboration work learners. Application area is a collection of applications and provides a ubiquitous learning or self-learning, home education and collaboration learning, distance conference, and self-evaluation. The system provides e-learning with an intuitive shared whiteboard and application program sharing to promote group collaboration.

2.2.1 Application Human Interface

This system provided in lesson plan production, interactive lesson, and evaluation of lesson. There are four application areas that were developed [10]: self-learning or collaboration learning, self-evaluation, home study or collaboration learning, and distance conference. The floor control window controls the floor among learners, and it consists of video image window as many as the number of students who learners in the session. The video window is used for monitoring the video of a remote learner, and it displays the video image of the learner who has the floor control. The video window allows the learner to select and view the video clip. And the video window can be displayed simultaneously with a document or whiteboard information so the education can stay focused on lecture. The shared window is a window shared by all the learners, and the modification carried out by the speaker is notified to every other learners.

The local window is not shared except initial file sharing, and each learner can modify it as needed. The local window has the lecture plans which are distributed at the beginning, and enables learners to memo and browse other parts in the lesson plans, and has functions as a blackboard. The tool box provides various tools for editing contents of both the shared window and the local window. The toolbox of button is menu box for the AVI file play, Internet service, etc.. The whiteboard in top right of the screen serves as a blackboard in conventional classroom, which is an education assistant tool to write texts, draw pictures, or fill colors, and provides application program sharing with other learners and interactive education. The process for activation of collaboration learning is described below:

- The teacher prepares a lesson plan using the editor provided by the distance collaboration learning system, and the lesson plan is kept in the DB of the distance learning system.
- The teacher dispatches an invitation message of collaboration discussion to the proper students who have joined the environments.
- Each student participates in the distance collaboration learning session using his or her name.
- The teacher distributes the lesson plans to the students, and a lesson and discussion starts. After the lesson is activated, questions, answers, and discussion are done interactively in the session.

2.2.2 Advanced Service Function (Application Program Sharing)

There are two types of application program sharing. One is centralized architecture and another is replicated architecture. Since replicated architecture can only transmit management data and event data, it can reduce communication overhead. However, it has the program where the learner has to have the same application program. Software provides various execution modules through different vendors.Application program requires each student to own it. Also the problem of command serialization can be solved through invoking two applications at ones. To solve these problems, central architecture was designed and implemented [11]. The method of application-sharing program made use of windows hook function. A hook is a mechanism by which a function can intercept events (message, mouse action, key strokes) before they reach in application. Functions that received event are called event distributor and are classified according to the type of event they intercepted. Event distributor sends the event data to application program and receives processing result. The result is displayed to the own monitor and sends to remote event distributor. In case of graphic image, they are transmitted at changing of graphic image which is snatched from GDI (graphics device interface) function. GDI is communication between the application and the device driver, which performs hardware-specific functions that generate output by acting as buffer between applications and output devices. Event distributor snatches messages and sends the message to remote site for same operation.

2.2.3 Service Functions

Service functions provide the following services:

2.2.3.1 Session Management Module

Session management manages access to whole session. Session management not only restricts access, it facilities access. It can also allow learners in a session to find others and bring them into the session. Session management deals with session start/termination, join/invitation/leave, and late comers. It may also allow sub-sessions and permit to join another session. Session management has an object with various information for each session, and it also supports multi-casting with this information.

2.2.3.2 Floor Management Module

Floor management manages the learner who can talk and learner who can change the information. In this module, initially, it is set to teacher-mediated floor management, but it can be changed while in session. Mechanism of the floor management consists of brainstorming, priority, mediated, token passing, and time-out. In floor management module, it provides explicit floor management and brainstorming.

2.2.3.3 Concurrency Management Module

Concurrency management is inevitable to allow multiple learners to be in safe collaboration in distributed multimedia environment.

2.2.3.4 Window Overlays Module

This is laid by a simple sketching tool over a copied window. It provides all users with transparent background and tele-pointers. So all users can point and gesture.

2.2.3.5 Window Sharing Module

This is a combination of window copying, window overlays, floor management, and session management. All users are able to interact through application shared by them. One user is running a single user application. The other users get to see exactly what this user sees. The application can allow different users to interact with the application by selecting one of the user's keyboard and mouse as the source of input.

2.2.3.6 Media Management Module

This module manages the creation and deletion of the service object for media use and media share between remote learners. And it also limits the service by hardware constraint. Media module supports convenient module for application using the environment. Supplied module is the creation and deletion of the service object for media use. Media module limits the service by hardware constraint.

2.2.4 Communication Service Module

The communication service module is in charge of data transportation among PCs in distributed environment and used by other service modules. The communication service module creates the network connections which altogether form a collaboration work, destroy, and experiment effective system.

2.3 Evaluation Framework for CEVEs

It is important when planning an evaluation to determine which items are assessable. This is often the most complex part. This collection of items is necessary to formulate specific questionnaires and hence to find and eliminate disturbance factors from the implementation of a CEVE. The evaluation goals and the evaluation criteria are usually concurrently defined since they affect each other mutually. In our research, we discovered that criteria varied considerably between evaluations [12].

The common criteria used among the majority of researchers include effectiveness, transparency, confidence, usability, interaction, application, collaborative work, system-related criteria, and the sense of copresence. Considering all these evaluation items in one session is almost impossible since the items mentioned above evaluate too many different aspects of HCI. Also, there is no mutually accepted array of criteria or evaluation framework which is compatible with all educational software [13]. The broadness of CEVE evaluation criteria constitutes an obstruction in the evaluation process. This has been circumvented by many researchers who propose specific criteria partitioning. These partitions differ greatly in number, purpose, and scope. Some partitions simply help categorize the criteria while others constitute distinct phases or sessions of the evaluation process. Regardless of the type or model of methodology followed by the evaluator, software evaluation is comprised of certain successive phases. The adoption and utilization of CEVEs for supporting the pedagogical process requires a new type of evaluation methodology or framework. In other words, evaluation should not be limited to system and usability assessment but should also focus on the pedagogical added value of the medium, as well as the new affordances made available through its application.

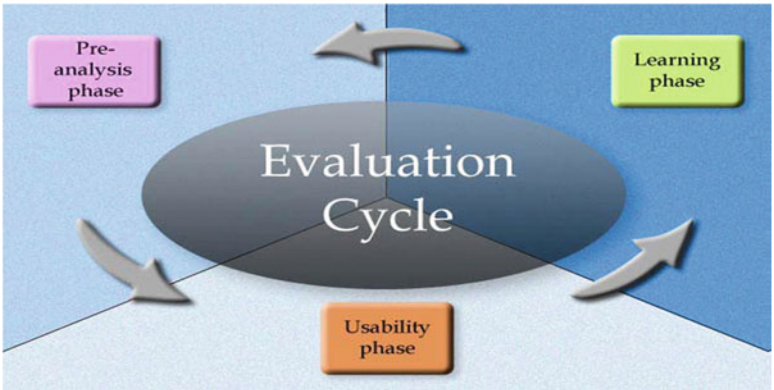

Fig. 2.2 Overview of an evaluation cycle for CEVEs

The rationale concerning the evaluation framework [14] for CEVEs is to organize the evaluation process based on the idea of iterative and incremental development process of an educational VE. An iterative and incremental development process specifies continuous iterations of design solutions together with users. According to [35], iteration includes:

(a) A proper analysis of the user requirements and the context of use
(b) A prototype design and development phase
(c) A documented evaluation of the prototype. Therefore, concerning the evaluation process, that is the main interest in this chapter, we need to conduct various evaluation cycles in order to evaluate each prototype of the system. The evaluation of each prototype system will result in suggestions for modifications in the following version of the prototype system design. In the case of a CEVE, we propose to conduct three phases in each evaluation cycle (Fig. 2.2), namely:

- Pre-analysis phase
- Usability phase
- Learning phase

A brief and general description regarding the necessity of the above phases as well as useful techniques for their successful conduct is presented in the following paragraphs.

Pre-analysis phase. Formative evaluation must pay attention first to usability and second to learning outcomes. Enhancing this idea, as shown in Fig. 2.3 [15], evaluation goals can be defined in the form of questions. Two types of questions can be formed [35]:

1. The evaluation methodology questions
2. Evaluation questions

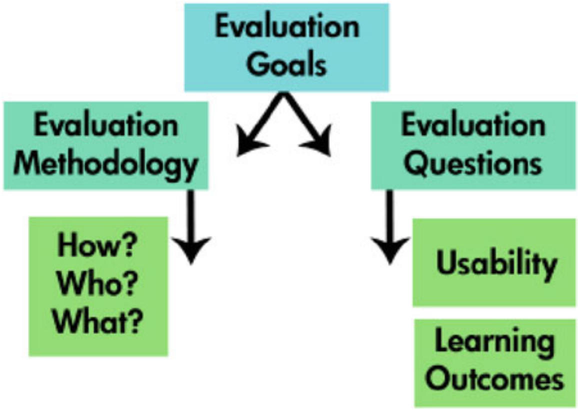

Fig. 2.3 Organizing the evaluation goals

The evaluation methodology (meta-evaluation) questions concern questions regarding the general process of evaluation [16]. Usually, the selected evaluation methodology or framework contains specific inherent goals. For example, the experimental model checks and evaluates the technical characteristics of the software, and its purpose is to reveal design issues concerning functional requirements [33]. On the other hand, the teacher-as-a-researcher model uses the teacher in order to assess the effect of the software in class and can help reveal prejudice problems, role conflicts, and student overworking.

In any case, before selecting a specific evaluation methodology, the evaluator's desired outcomes should be in consonance with the possible results of a framework [17]. A list of questions that can aid evaluators in detecting the appropriate metrics and selecting a fitting methodology was presented in [18]. The evaluation questions concern questions regarding usability and learning outcomes. Usability refers to the ability of the system to support the learning process. This covers the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments. Furthermore, in the usability questions, the characteristics of the system (e.g., avatars, nonverbal signals, and communication tools) are evaluated.

The learning outcome questions concern pedagogical research. Learning outcomes are derived from educational objectives since teaching, like research, is a purposeful activity. Learning outcomes represent the translation of aims into specific, tangible, attainable terms. For the definition of learning outcomes and objectives, [19] can be used. In order to help teachers understand and implement standard-based curriculum, Bloom's taxonomy has been revised. Classifying instructional objectives using the revised taxonomy helps to determine the levels of learning included in an instructional unit or lesson [34].

Furthermore, in this phase, the evaluator can gather information regarding the individual learning styles. This information can then be used in conjunction with questionnaire or interview results to ascertain the validity and weight of a learner's opinion recorded in the other phases. For example, during the learning phase, the tutor presents learning objects by utilizing a specific pedagogic approach. If the selected approach is not in accordance with a learner's learning style, then his or her opinion will probably bear a fair amount of subjective negativity and must therefore be judged in a lighter objective fashion. According to Edwards et al. [20], the Felder-Silverman learning style model (FSLSM) seems to be the most appropriate for use in computer-based educational systems as it describes the learning style of learners in more detail than other models. For identifying the learning styles according to FSLSM, the Index of Learning Styles, a 44-item questionnaire, can be used. Some example types of learners according to the FSLSM are [21]:

- Active learners, which learn by trying things out and working with others
- Reflective learners, which learn by thinking things through and working alone
- Visual learners, which remember best what they have seen
- Verbal learners, which get more out of words, regardless whether they are spoken or written

Usability phase. Usability inspections of the initial applications are necessary so as to uncover the main design flaws and allow a cleanup of the design, meanwhile adapting the method to 3D collaborative aspects. Usability and interaction are very much interrelated. Concerning interaction, social-arbitrary knowledge (i.e., language, values, rules, morality, and symbol systems) can only be learned in interactions with others. Several HCI rules for display design must be taken into account when implementing any e-learning system. These include consistency of data display, efficient information assimilation by the user, use of metaphors, minimal memory load on user, compatibility of data display with data entry, flexibility for user control of data display, presentation of information graphically where appropriate, standardized abbreviations, and presentation of digital values only where knowledge of numerical value is necessary and useful.

Learning phase. The main goal of the learning evaluation phase is to conduct pedagogical research. As proposed by Ogata and Yano [22], the model presented can be a useful guide in designing, developing, and evaluating a VR learning environment. Although this model is focused on immersive VEs, it could also be used in desktop CEVEs in order to address which CEVE features are appropriate, what kind of students might gain benefits through learning in CEVEs, and how CEVEs enhance learning by looking into the interaction and learning experience. Therefore, our proposed evaluation framework is based on the rationale of this model in order to test scientific hypotheses concerning learning and communicating in VEs through experimental studies.

2.4 Collaborative Argumentation in Learning Resource Evaluation and Design

There are several reasons why producing high-quality multimedia learning resources is challenging. Many types of media, media features, and design models are available to resource developers, yet there are few standards that can guide in selecting them. Relevant research on multimedia learning has expanded, yet many developers are unaware of its full scope and value. Personnel are available who specialize in media development, instructional design, usability design, subject knowledge, and teaching, yet they are rarely coordinated so that that their expertise can be effectively brought to bear. Learners usually have opinions about the resources they use, yet their opinions are rarely heard by developers.

The challenge is seen most clearly when design decisions are informed by conflicting recommendations from different specializations. Decisions about text layout are a case in point. Psychologists and educational researchers who have studied readers using computer screens to read text with a fixed number of alphabetic characters per line have observed that more characters per line (possibly up to 100) may be optimal for rapid reading, but that as few as 40 or 50 characters per line may be optimal for reading comfort and comprehension. Bhatt [23] concluded that "longer line lengths should be used when information is presented that needs to be scanned quickly and shorter line lengths should be used when text is to be read more thoroughly, rather than skimmed." Specialists familiar with this research who are designing the text components of a resource to be used for a defined learning activity might choose a fixed line length of, say, 70 characters. On the other hand, many Web developers advocate a "liquid design" for Web pages in which the number of characters per line varies according to the width of the browser window, character size, and presence of images [22]. They argue that readers can resize the browser window to the optimal width for normal reading or to a much wider width that minimizes scrolling when scanning through a large document. Because neither fixed nor liquid approaches to line length are likely to be the best choice in all design situations, an analysis of how specific circumstances play into the decision seems necessary, and that process requires knowledge of both the fixed length and flexible length strategies [24]. Finding the best design solutions and evaluating existing designs requires an exchange of specialist knowledge in relation to situated learner needs. The nature and requirements of this exchange are the concern of this chapter.

Any approach to ensuring quality in learning objects that is built around rigid standards for technologies or implementation will quickly become obsolete. Instead, what is needed is a system for evaluating learning objects that applies design principles, recognizes that the best way to operationalize these principles will change from context to context, and has a mechanism for continued interpretation and clarification of how these principles relate to specific learning objects. We maintain that continued interpretation of quality standards requires reasoned discussion or argumentation among learning object stakeholders – media developers, instructional designers, instructors, students, and so on – and that this argumentation can also serve as a form of professional development for the stakeholders. Such dialogue provides the opportunity for professionals and students to test their ideas and see the views of other stakeholders who may be approaching the same object from different professional perspectives [25].

The purpose of this chapter is to present theory and evidence that collaborative argumentation can be a powerful method for the design and evaluation of multimedia learning resources. We describe how a model of collaborative argumentation that we have developed, convergent participation, has been used to evaluate learning resources and provide professional development for learning resource designers. Before taking up this main theme, we introduce an instrument for evaluating multimedia learning resources that offers substantive guidance to collaborating reviewers.

Most learning object evaluation rubrics are designed for use by teachers and focus on content, pedagogy, and usability. For example, the evaluation rubrics used by Vicki and Jun [26] advise users to consider quality of content, potential effectiveness as a teaching tool, and ease of use. The Learning Federation (n.d.) asks users to "evaluate learning objects for educational soundness, functionality, instructional design and the overall fit to the educational purpose for which they were designed." Europe's ELEONET (n.d.), on the other hand, emphasizes a different area of quality evaluation. It evaluates technical aspects of learning objects, specifically, the metadata used to describe objects registered in a repository. LORI addresses all these areas of quality and others we believe are important. The nine LORI items broadly and concisely deal with key features of learning object quality. Because most learning object evaluators are not hired specifically to conduct reviews or formally trained in the broad range of quality issues, LORI cues reviewers to important areas of consideration. The current version of LORI has been informed by literature reviews and feedback from users in learning object quality studies and in professional development workshops for teachers and other stakeholders.

The first two items in LORI, content quality and learning goal alignment, are equally applicable to printed instructional materials and electronic resources. Content quality is usually emphasized in learning object evaluation instruments and is often given high priority by teachers. Zhang et al. [27] showed the negative impact that biases and errors in traditional textbook content can have on student understanding. In the domain of digital learning resources, where there is less regulation of content validity, reliability, and credibility, there may be even greater cause for concern about content quality. Goal alignment is a second feature that may be more neglected in multimedia resources than print textbooks. We believe that learning resource designers and evaluators should be aware of the benefits of close alignment across learning goals, learning activities, and assessments.

The next three items – feedback and adaptation, motivation, and presentation design – focus on established areas of instructional design. The feedback and adaptation item asks whether the object tailors the learning environment to the individual learner's characteristics and needs and provides feedback that is dependent on the learner's input. Feedback and adaptation has long been understood by instructional designers as an important goal for educational technology, whether manifested as simple knowledge of results on quiz items, or as adaptation of the learning environment to a sophisticated model of the learner. The motivation item [28] asks whether the object encourages learners to invest effort in working with and learning from the object. This item encourages raters to distinguish between objects that attempt to motivate by superficial complexity, such as flashing graphics, and those that engage learners existing interests and develop new ones. The presentation design item asks whether the object communicates information clearly. It draws evidence-based principles from the field of multimedia learning and established conventions for multimedia design. The presentation design item also references established stylistic conventions for clearly and concisely communicating information through graphical displays and writing.

Two items, interaction usability and accessibility, relate to learners' experience as software users. The interaction usability item assesses interface transparency, that is, how effortlessly and efficiently users can operate links, controls, and menus to navigate through the object [29]. It is important to distinguish between the challenges posed by the interface, which incur extrinsic cognitive load, and those posed by the instructional content, which may be germane to the learning goals. Any errors a student makes should be related to learning the content, not to navigational difficulties. In LORI, interaction usability is treated separately from concerns about how learners perceive and interact with the learning content. The accessibility item invites reviewers to consider the important issue of how objects can be designed to take into account differing abilities to access content. For example, Goebbels et al. [30] observed that the increasing prevalence of graphical user interfaces has produced a situation in which "blind users find the Web increasingly difficult to access, navigate, and interpret. People who are deaf and hard of hearing are served Web content that includes audio but does not contain captioning or text transcripts" (Preface: Who are you?). The Web Content Accessibility Guidelines established by the World Wide Web Consortium [31] provide useful information on how Web pages can be designed to offer consistent meaning when accessed through a range of browsers, assistive technologies, and input devices.

The final two LORI items, reusability and standards compliance, address managerial and technical matters that support the users' experience. The reusability item addresses one of the purported benefits of using learning objects: the ability for one development team to create a resource that can be reused by learners across many different courses and contexts. Finally, standards compliance addresses the need for consistent approaches to learning object metadata creation and use. Metadata (data about data) is the information that users actually search when looking for learning objects. Several organizations have been actively developing and promoting usable metadata standards. Graf and Kinshuk [32] sum up the benefits of a consistent approach to metadata creation and use: "searching becomes more specific and in-depth; managing becomes simpler and uniform; and sharing becomes more efficient and accurate."

LORI spans quality issues that are often considered the responsibility of different stakeholders, and its scope is so wide that few professionals charged with developing learning multimedia resources have detailed knowledge of all that it covers. Wherever subjective judgments of quality are applied, as they must be in using LORI, evaluations are only as good as the knowledge of the evaluators. Clearly then, the problem of advancing quality evaluation extends beyond merely translating design knowledge into evaluative criteria and overlaps significantly with problems of educating novice designers and broadening the knowledge of practicing design professionals. Next, we consider how the process of evaluation can contribute to the education of designers.

2.4.1 Evaluate to Learn

Multimedia learning resources are designed objects. As such, knowledge about how to construct them delineates a design discipline that belongs, along with engineering, computing science, architecture, among the "sciences of the artificial" described by Graf and Kinshuk [32]. With contributions from cognitive science, educational psychology, and relevant areas of educational research, a design science has emerged that advances theories, principles, and prescriptions for designing multimedia learning resources. The science informs a practice that must intentionally and reflectively bend theory to the exigencies of the situation in which the resources are used.

Educational programs for instructional designers typically present curricula in which the novice designer learns some of the theory, history, and tools of the field and is soon engaged in design projects. Of course, in the design sciences, "designing to learn" is not an innovative instructional strategy but instead a traditional and widely practiced method that is rightly regarded as a core element in design education. Designing and developing a complete learning resource can take more time than is available within a single course. As a result, students may be assigned projects that are reduced in some way; perhaps, only the design stage is completed, or only a portion of the planned content is implemented. When a student devotes much of his or her learning time to a single project, depending on the nature of that project, he or she may not have opportunity to comprehensively practice the design knowledge developed in a course. Further, design projects are often conducted individually, whether for purposes of individual evaluation, to meet unique student interests, or to allow students to design for the needs of their workplace. This can mean that students have few opportunities to discuss in detail the rationale for their design decisions.

Collaborative evaluation of learning resources can effectively complement design projects in professional development and graduate courses that teach learning resource design. The main advantage of evaluate-to-learn as an instructional strategy is that a learning object can be critiqued in less than an hour, allowing students to evaluate many cases within a single course or allowing professionals to complete evaluations within a workshop or as part of regular design work. Because real, fully developed learning resources can be evaluated, this form of case-based learning can compensate for authenticity that is lost when design projects must be scaled down to fit an academic term.

2.4.2 Collaborative Argumentation

Collaborative argumentation differs from the common understanding of argumentation as personally invested debate or persuasive rhetoric and is antithetical to the sense of argumentation as verbal conflict or quarrelling. Martens [5] claims that collaborative argumentation is the essence of discourse in science and the means by which competing theories are assessed against data and the scientific community finds agreement. Even more broadly, collaborative argumentation can be viewed as a decision-making process used in many professional fields such as medicine, engineering, and business. It is a form of productive critical thinking characterized by evaluation of claims and supporting evidence, consideration of alternatives, weighing of cost and benefits, and exploration of implications.

Researchers in the learning sciences have proposed that argumentation, particularly collaborative argumentation, can be a highly effective instructional strategy. Argumentation may help learners to understand course content, enhance their interest and motivation, and improve performance on problem solving tasks. In a study by Martens [5], students who wrote arguments about historical demographic changes in Ireland showed deeper understanding of the causes of demographic change than students who wrote summaries or explanations. Ogata and Yano [22] found that sixth grade students were more motivationally engaged in argumentative discussions of stories than in traditional recitation discussion of the stories. A review of the psychological literature on problem solving [12] concluded that people's problem solving performance is enhanced when they are instructed to generate counterarguments or alternative reasons.

Although little evidence is available about the effects of argumentation in the workplace, there is no reason to assume that its benefits for learning, motivation, and performance are restricted to formal educational settings. The collaborative argumentation process, whereby participants make their reasoning and knowledge explicit and co-elaborate their understanding of problems and situations, is likely an effective form of learning in organizations and professions. As with narrative, collaborative argumentation may be one of the activities that comprise cognitive apprenticeship.

The nature of collaborative argumentation may depend on whether the participants bring shared knowledge and fill similar roles in an organization or project or specialize in different disciplines and fill different roles. Participants from similar backgrounds often share a great deal of background knowledge that remains implicit throughout a discursive interaction. In this case, the participants are likely to develop a complex set of claims, points of evidence, and counterarguments cognate to the shared knowledge. For example, three Web developers collaborating on a learning object project may generate richly detailed arguments about image formats but have relatively little to say about learning goals. On the other hand, when the participants have differentiated expertise, the discussion may become simply an exchange of explanations rather than collaborative argumentation. For example, the subject matter expert may explain a misconception held by novices, the instructional designer may explain why a diagram might overcome the misconception, and the Web developer may explain how the diagram will be implemented. Although an explanatory discussion of this type has the needed breadth, it lacks the depth offered by collaborative argumentation in which claims are expected to be challenged and supported by evidence. For teams charged with developing learning resources, an important challenge is how to enhance the depth of analysis afforded by collaborative argumentation among team members with differentiated experience and knowledge. We believe that inviting stakeholders to commit to a set of ratings and supporting explanations in a common evaluation framework and then discuss the reasons for those ratings in a diverse team will lead to the observed benefits of collaborative argumentation. We call this process convergent participation.

2.4.3 Future Trends in Argumentation for Evaluation and Design

Until now we have investigated the use of convergent participation in graduate education and in workshops for teachers and educational technology professionals. What broader effects can be expected when the convergent participation model for collaborative evaluation is introduced into a community of learning object developers and users? First, we anticipate that participation in collaborative evaluation will facilitate adoption of quality as a communal goal. Just as there is a recognition of the need for formal approaches to ensuring quality in more traditional publishing domains, such as textbooks and journal articles, community members will become more aware of the need for quality assurance processes in learning objects and will become better informed about the detailed meanings of learning resource quality. We anticipate this will create a demand for higher quality learning resources [5].

Second, as participants become practiced in the use of evidence-based reasoning to support design decisions, they will become aware of gaps in their knowledge of relevant research evidence. Consequently, they may become more active in seeking research that bears on their design decisions. We anticipate that participants will eventually become aware of gaps or weaknesses in the available evidence, leading to an increased demand for specific research. To this point, LORI and the convergent participation model have been used only for summative evaluation. That is, resources have been assessed only after they have been completed and made available through the Internet. A natural adaptation of the model, within a community of resource developers, would be to use it formatively to support design decisions [31]. To use LORI and convergent participation for formative evaluation, one would have stakeholders collaboratively review plans and prototypes. Learning object development involves progress through phases, with only certain features developed within a phase. For example, a navigational scheme may be developed in one phase and the audiovisual content may be developed in a subsequent phase. Therefore, a formative adaptation would likely stage the assessment of the quality dimensions to parallel the development of corresponding features of the learning object.

2.5 Conclusion

Collaborative argumentation is suitable for adapting design principles because it brings to the fore the differing beliefs and knowledge of diverse stakeholders. However, without appropriate tools, protocols, and moderation, attempts at collaborative argumentation may focus on surface level explanations, without reaching the level of deep discussion. Using collaborative argumentation within a convergent participation structure may be an effective means for fostering deep, nuanced understanding of design principles because the process requires participants to explain the reasons for their decisions to apply principles in certain ways. The collaborators with certain interests and knowledge are the priority choice. We are designing our message service from a group collaboration point of view, that is, to provide message services for group collaboration, such as discussion, instant messenger, message exchange, message filtering, push message, and message synchronization within a group. In our design of group collaboration, each peer is free to initiate a special interest group and free to apply to join any special interest group initiated by other peers in the peer-to-peer network.

References

1. Graf, S., & List, B. (2005, July 5–8). *An evaluation of open source e-learning platforms stressing adaptation issues*. IEEE International Conference on Advanced Learning Technologies (ICALT 2005), Kaohsiung, Taiwan.
2. ISO. (1998). *ISO 9241–12: Ergonomic requirements for office work with visual display terminals (VDTs) – part 11: Guidance on usability*. Geneva: International Organization for Standardization.
3. Koubek, A., & Muller, K. (2002, November 16–20). *Collaborative and virtual environments for learning*. ACM SIG Proceedings, New Orleans, LA.
4. Lee, E. A. L., & Wong, K. W. (2008). A review of using virtual reality for learning, lecture notes in computer science. In Z. Pan et al. (Eds.), *Transactions on edutainment I, LNCS 5080* (pp. 231–241). Heidelberg: Springer. doi:10.1007/978-3-540-69744-2.
5. Martens, A. (2003, April). *Support cognitive processes in intelligent tutoring systems*. Proceedings of the International Conference on Cognitive Modeling, Bamberg, Germany.
6. Paramythis, A., & Loidl-Reisinger, S. (2004). Adaptive learning environments and e-learning standards. *Electronic Journal of eLearning*, *2*(1). Retrieved Jan 28, 2012, from http://www.ejel.org/volume-2/vol2-issue1/issue1-art11.htm.
7. Bruce, B. C. (2008). Ubiquitous learning. In W. Cope (Ed.), *Ubiquitous learning*. Champaign, IL: University of Illinois Press.
8. Henda, C., & Mohamed, J. (2004). PERSO: Towards an adaptive e-learning system. *International Journal of Interactive Learning Research, 15*(4), 433–447.
9. Sung, J. S. (2009). Application Protocol Design for Collaborative Learning, International Journal of u- and e- Service, Science and Technology, Vol.2, No.4. December, 2009.
10. Po-Sheng, C., Yen-Hung, K., Yueh-Ming, C., & Tzung-Shi, C. (2008, July). *A meaningful learning based U-learning evaluation model*. In 2008 Eighth IEEE International Conference on Advanced Learning Technologies, Santander, Spain.
11. Chang, C. Y., & Sheu, J. P. (2002, August 29–30). *Design and implementation of ad hoc classroom and e-schoolbag systems for ubiquitous learning*. Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education, Växjö, Sweden.
12. Qu, C., & Nejdi, W. "Interacting the Edutella/JXTA Peer to Peer Network with Web Services", Proceedings of the 2004 International Symposium on Applications and the Internet (SAINT'04).
13. Schilit, B., Adams, N., & Want, R, (1994, December 8–9). *Context-aware computing applications*. Paper presented at the Workshop on Mobile Computing Systems and Applications, Santa Cruz, CA.
14. Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals, Handbook 1: Cognitive domain*. New York: McKay. ISBN 978–0582280106.
15. Bruckman, A., & Bandlow, A. (2002). HCI for kids. In J. Jacko & A. Sears (Eds.), *The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications*. Mahwah, NJ: Lawrence Erlbaum and Associates.

16. Chee, Y., & Hooi, C. (2002). C-VISions: Socialized learning through collaborative, virtual, interactive simulation. In *Proceedings of CSCL 2002: Conference on Computer Support for Collaborative Learning, Boulder, CO* (pp. 687–696). Hillsdale, NJ: Lawrence Erlbaum.
17. Churchill, E., Snowdon, D., & Munro, A. (2001). *Collaborative virtual environments: Digital places and spaces for interaction*. London: Springer. ISBN 1852332441.
18. Dickey, M. (2005). Brave new (interactive) worlds: A review of the design affordances and constraints of two 3D virtual worlds as interactive learning environments. *Interactive Learning Environments, 13*(1), 121–137.
19. Cat, K., & Peter, H. (2005). Designing agents for feedback using the documents produced in learning. *International Journal on E-Learning, 4*(1), 21–38.
20. Edwards, K., Newman, M., Sedivy, J., Smith, Y., Balfanz, D., Smetters, D. K., et al. (2002, November 16–20). *Using speakeasy for ad hoc peer-to-peer collaboration*. Paper presented at ACM 2002 Conference on Computer Supported Cooperative Work (CSCW 2002), New Orleans, LA.
21. Haruo, N., Kiyoharu, P. H., Yasufumi, K., & Shiho, M. (2003, August 13–15). *Designing ubiquitous and universal learning situations: integrating textbooks and mobile devices*. Paper presented at the 19th Annual conference on Distance Teaching and Learning, 2003, Madison, WI.
22. Ogata, H., & Yano, Y. (2004, March 23–25). *Context-aware support for computer-supported ubiquitous learning*. Paper presented at the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, JhongLi, Taiwan.
23. Bhatt, G. D. (2001). Knowledge management in organizations: Examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management, 5*(1), 68.
24. Biström, J. (2005, April). *Peer-to-peer networks as collaborative learning environments*. Paper presented at HUT T- 110.551 Seminar on Internetworking. Retrieved October 25, 2005, from http://www.sit.fi/~johnny/collp2p.pdf
25. Sung, J. S., & Lim, D. H. (2006). Adaptive tutoring and training system based on intelligent agent. *IJMUE, 1*(3), 6–11.
26. Vicki, J., & Jun, H. J. (2004, December). *Ubiquitous learning environment: An adaptive teaching system using ubiquitous technology*. Proceedings of the 21st ASCILITE Conference, Perth, Australia.
27. Zhang, J., Jin, Q., & Lin, M. (2005, March 28–30). *A framework of social interaction support for ubiquitous learning*. Paper presented at the 19th International Conference of Advanced Information Networking and Applications, Taipei, Taiwan.
28. Felder, R. M., & Soloman, B. A. (1997). *Index of learning styles questionnaire*. Retrieved July 20, 2009, from http://www.engr.ncsu.edu/learningstyles/ilsweb.html
29. Gay, L. R., Mills, G., & Airasian, P. (2000). *Education research: Competencies for analysis and application* (6th ed.). Upper Saddle River, NJ: Merrill. ISBN 978–0131185340.
30. Goebbels, G., Lalioti, V., & Göbel, M. (2003). Design and evaluation of team work in distributed collaborative virtual environments. In *Virtual Reality Software and Technology Proceedings of the ACM Symposium on Virtual Reality Software and Technology, Osaka, Japan* (pp. 231–238). New York: ACM Press.
31. Goransson, B. (2001). *Usability design: A framework for designing usable interactive systems in practice*. IT Licentiate theses 2001–06 [ISSN 1404–3203], Department of Human Computer Interaction, Information Technology, Uppsala University, Uppsala, Sweden.
32. Graf, S., & Kinshuk, K. (2006). Considering learning styles in learning management systems: Investigating the behaviour of students in an online course. *SMAP '06, First International Workshop on Semantic Media Adaptation and Personalization, Athens, Greece*. Washington, DC: IEEE Computer Society. ISBN: 0-7695-2692-6.
33. Lawton, D. (Ed.). (1978). Curriculum evaluation: New approaches. In *Theory and practice of curriculum studies* (pp. 176–185). London/Boston: Routledge. ISBN 0710000286, 9780710000286.
34. Sung, J. S. (2009) "U-Learning Model Design Based on Ubiquitous Environment", International Journal of Advanced Science and Technology, Volume 13, December, 2009
35. Tsiatos, T., Andreas, K., & Promportsis, A. (2010). Evaluation framework for collaborative educational virtual environments. *Educational Technology & Society, 13*(2), 65–77.

Springer
http://www.springer.com/978-1-4614-3633-1

Virtual Communities, Social Networks and Collaboration
Lazakidou, A.A. (Ed.)
2012, XII, 249 p. 55 illus., 21 illus. in color., Softcover
ISBN: 978-1-4614-3633-1