Evaluation Model For Real and Virtual Learning Environments: Theoretical Concept and Empirical Results

Dr. Kerstin Fink and Dr. Friedrich Roithmayr
Department of Value Process Management–Information Systems, University of Innsbruck, Austria
Tel: (+43) 512 507-7650 or -7658, Fax: (+43) 512 507-2844, {Kerstin.Fink, Friedrich.Roithmayr}@uibk.ac.at

OBJECTIVE AND RESEARCH PROBLEM

Virtual learning is a way to empower a workforce with the skills and knowledge that is needed to turn the changes to a business advantage. Virtual learning environments distinguish from traditional learning environments by three key factors:
- Missing face-to-face communication,
- Lack of continuous feedback between the students and teachers,
- Missing theoretical models for implementing an evaluation process.

In virtual learning environments the students have no direct interaction with the instructor in order to receive more information about a course or discuss problems about the general performance. Especially in virtual learning environments it is necessary to have a good evaluation model and a constructive feedback situation. The authors' experiences have shown that in virtual learning environments students overreact more vehemently to problems than in traditional learning environments. Therefore the research problem is to improve the quality of the knowledge transfer to students. In this article we introduce a theoretical model for the evaluation of traditional classroom and e-learning situations. In future learning environments there will be a combination of face-to-face and of virtual learning elements. It is important to evaluate not only the e-course content but also the quality of the instructors and materials. Current e-learning programs in higher education require a comprehensive planning that allows also evaluation processes.

Virtual learning and education concepts are discussed in many publications [EmRe01; Rose01, www.webct.com, www.embanet.com]. However, evaluation models for virtual learning processes are missing. E-learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance [Rose01, 28ff.]. Rosenberg [Rose01] sees three fundamental criteria: (1) e-learning is networked, which makes it possible for constant updating, (2) it is delivered to the end-user via a computer using standard Internet technology, (3) it focuses on the broadest view of learning and goes far beyond computer-based-training (CBT). In a traditional classroom situation, the lectures can observe the student's reactions and on the other side the students can interview the lecturer for additional knowledge to gain more insights. An e-learning situation demands an evaluation even more, because there is no additional information about the performance. Through evaluation it is possible to measure:
- The reaction of the students in and on the reflection process.
- The increase in knowledge for every student.
- The performance of the lecturers at transferring knowledge.

While the term computer based training (CBT) is more oriented to offline learning, the terms e-learning and telelearning refer to the idea of interactive online learning and will be used synonymously. The generic term is "virtual learning concept". Virtual learning concepts are a combination of learning, training and knowledge transfer by using new computer technologies (e.g. videoconference, internet, software tools and so on). In future curricula the training will be a combination of classical training methods broadened by virtual learning concepts. In all cases *quality assurance* [QuAM01; FIBA01] plays a significant role. Accreditation, validation and evaluation are important steps in quality assurance of an education program. Therefore evaluation processes are very important tasks [DRAF01] and nowadays we find them as quality assurance methods in all educational concepts.

THEORETICAL FRAMEWORK – THE EVALUATION MODEL

Basic Concept

The authors have developed a three dimensional framework (Figure 1) for measuring learning environments. The evaluation model can be applied to all electronic and non-electronic components of learning. The **1st dimension** is called the **reflection process.** The theory of Schön [Schö83; Schö87] is the basic framework. The 1st dimension can be described as follows:
- The students and/or trainers are reflecting the quality of the content during the courses (*reflection-in-action*). Reflection-in-action refers to the immediately recursive thought a person puts towards an action. This kind of reflection is not able to measure dynamic group processes. A second measurement method is therefore needed to ensure the quality of the courses.
- This is called *reflection-on-action*. In a further reflection process the evaluation takes place at the end of the course. The students and/or trainers think about actions in the past; it's a post-activity reflection.
- There is *no systematic reflection*.

The **2nd dimension** is the **direction of the evaluation process.** There are three forms of evaluation communication. In a *two-way evaluation* both the students and the teachers are evaluated mutually. In a *one-way evaluation* communication, the other group evaluates only one group. The third form has *no systematic* in the direction of the evaluation communication. **Evaluation objects determine the 3rd dimension**: student, trainer, student and trainer, curriculum. The model has 48 basic evaluation units. A basic evaluation unit represents the cross point of the scaled three dimensions. An evaluation in a virtual learning environment relates to one or more basic evaluation units. A basic evaluation unit is the smallest measuring object in learning environments.

1st Dimension–Reflection Process

Schön's [Schö83; Schö87] major interest was in professional knowledge and education, which lead him to develop an overall epistemology of professional practice, based on the concept of *knowing-in-action* [Schö91]. Schön describes the action professionals bring to their everyday practice, under conditions of uncertainty, instability, uniqueness, and value conflict. Schön distinguishes between two reflection concepts. The first concept is called *reflection-in-action* and is the capacity to respond to surprise through improvisation. Professionals think about what they are doing as they do it, setting the problem of the situation anew, and conducting an action experiment on the spot by which we seek to solve the new problems they have set. The second concept is called *reflection-on-action*. By this Schön means, that those practitioners reflect on their reflection-in-action. When a practitioner does not reflect on his own inquiry, his intuitive understanding is kept tacit and there is no learning process. In the case of

Figure 1: Dimensions of the evaluation model
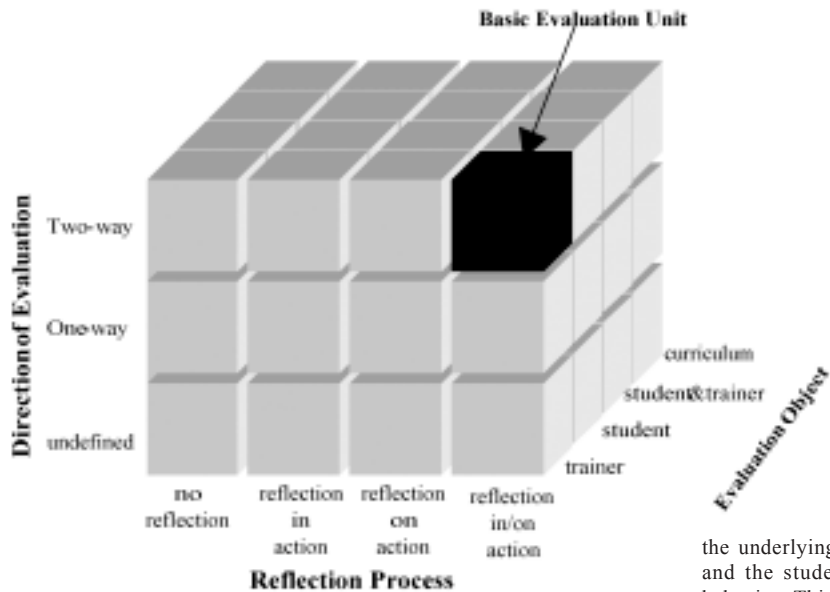
group learning, a group reflection can lead to a reconstruction of the meaning of the social situation and provides a basis for further action. Reflection has to be seen in a learning environment. Evaluation systems must also utilize the reflection-in-action and reflection-on-action model to get a valid information base about the quality of the online learning units. The reflection approach is the measurement tool for ensuring a high quality level for learning processes.

2nd Dimension–The Direction of the Evaluation Process

The "one-way evaluation" and the "two-way evaluation" are the major directions of the evaluation process. In the first case, the students have to answer some questions concerning the quality of the trainer and in addition the quality of the courses. Table 1 shows the basic questionnaire, which is divided into three groups of questions. Question 1 to 6 and 11 are focused on the course and the material of the course. Question 7 to 10 are related to the quality of the trainer while question 12 refers to the quality of the whole course. The measurement scale ranges from 1 (excellent) to 5 (not excepted). In table 1 the scales have to be interpreted as rating examples. The questionnaire has the function to get an overall idea about the rating of the trainer/course. However, additional to the questionnaire the students have the possibility to describe the problems in open sentences. The open questions have the objective to find out more about the reflection process.

On the other side, the evaluation process through the trainers is not based on a questionnaire; it is a verbal assessment of the students' qualification and behavior. Each instructor expresses his feeling about the courses and the students. The comment can range from a very detailed feedback to a general overview of the course. The objective of this structure is to have the possibility to crosscheck the evaluation results form the students with the trainer and to measure significant deviations.

To realize the two-way communication process, a regular feedback session should take place. The objective of the group discussion is first of all, to give the trainers/students a summary of the measurements results and second to prevent future conflict situation. Each group has the possibility to discuss improvements of the traditional and e-learning environments. For instance, if a trainer has only a very good theoretical knowledge, but is not a very good English speaker, a typical conflict situation exists. The feedback session can help to

evaluate if the students have given a good judgment of the situation or if they have overreacted to the situation and how the conflict can be solved. The success of the evaluation model resides in the combination of the reflection theory and the directions of the communication process.

3rd Dimension – Evaluation Object

The evaluation object can be the student, the teacher, the student and teacher, or the curriculum. Depending on the situation, different learning concepts for evaluation objects apply. Argyris and Schön [ArSc74, 18ff.] refer to *single-loop learning*, if a person learns to maintain the field of constancy by learning to design actions that satisfy existing governing variables; in *double-loop learning* a person learns to change the field of constancy itself. Learning means that errors are detected and corrected [Argy93]. If a mismatch occurs there are two ways to correct the error. In a single-loop learning process, the behavior is changed. However in double-loop learning, the correction of the error requires the change of the underlying program. If there is a mismatch between the program and the students expectations, than the first way is to change the behavior. This could be for example that a lecturer is replaced. If the evaluation shows that single-loop learning is not enough for the correction of the error, than a double-loop situation occurs. Meaning, part of the curriculum/courses or even the teaching concept have to be changed or adapted, depending what the result of the evaluation was. The reflection process leads to a questioning and change in frames of reference. Through the e-evaluation process a single-loop or double-loop process is initiated.

EMPIRICAL RESULTS

Test Object

The empirical test object is the "Master of Advanced Business Study Program (MAS)" which is a cooperation of the University of Innsbruck together with the SAP Austria. The empirical results refer to case studies done at the MAS during the year 2000/2001. At the

Table 1: Questionnaire

No.	Question	Objective of the Question	Rating
1	How would you evaluate the structure of the course?	Course/Material	4
2	Were you satisfied with the length and the time sequence of the course?	Course/Material	3
3	How suitable were the tasks (practice exercises) in terms of reinforcing the content of the course?	Course/Material	2
4	How would you evaluate the proportion between the lecture and practical exercises/tasks in the course?	Course/Material	2
5	Can you apply the knowledge imparted in the course in practice?	Course/Material	2
6	How would you evaluate the course material (documentation)?	Course/Material	3
7	How would you evaluate the overall performance of the instructor?	Instructor	3
8	How would you assess the expertise of the instructor?	Instructor	1
9	How well was the instructor able to impart his/her knowledge to you?	Instructor	3
10	How well did the instructor handle your questions and problems?	Instructor	1
11	How would you evaluate the infrastructure of the course?	Course/Material	1
12	What overall grade would you give the course?	Whole course	3

"SAP Business School Vienna" a combination of traditional classroom training and e-learning programs is established. The combination of the two learning concepts is a central success factor for learning at the "SAP Business School Vienna", since knowledge comes from a variety of sources: the instructors/lecturers, the SAP Intranet, outside experts, the e-learning platforms. The students reflect in and on action about the courses/teachers/curriculum. Based on their impressions, the evaluation process takes places, which results in a single-loop or double-loop learning process (Figure 2).

Figure 2: Learning and evaluation
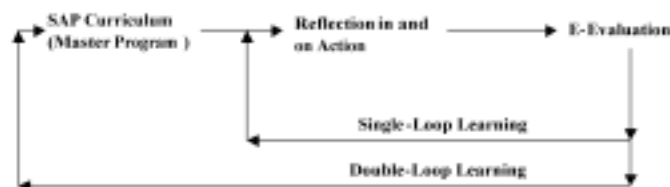
Statistical Analysis in a Face-to-Face Environment

The first statistical analysis concerns the evaluation of the MAS-data, which was gained from the face-to-face learning environment. In a time period of two semesters - thus comprising two separate MAS-classes - a total of 18 students participated in the evaluation. In a first attempt to analyse the data statistically, the structure of the answers to the posed questions making up the evaluation was assessed globally, including all students and courses. Consequently, each of the following statistical statements is based on a sample of approximately 3000, which is a sound base for reliable conclusions. The detailed questionnaire is explained in table1. Questions 1 through 6 and 11 are course-related, whereas questions 7 to 10 clearly refer to the quality of the instructor. Question 12 represents a résumé of the overall impression of the student with respect to that particular course. It can be anticipated that the outcome of question 12 will highly depend on the previous questions, however the degree of this dependency and the possible redundancy in the set of questions had to be assessed by quantitative methods.

A linear regression model was used with question 12 as the dependent variable and questions 1 through 11 as independent (predictor) variables. The cross-correlation table showed significant correlation coefficients between all the variables, signaling a consistent attitude of a particular student to all aspects of a given course.

A multiple regression procedure was performed using the step-wise method for the inclusion or exclusion of the independent variables. Selecting among all potential predictors (questions 1 through 11), the resulting model included questions 7, 9, 1, 11, 4, and 5 in this sequence reflecting the relative amount of their predictive power concerning the outcome of question 12. The coefficient of prediction (R Square), was 0.847, showing an excellent fit of the model. Considering all results, questions 7 and 9 seem to play a dominant role in predicting the outcome of question 12: If we only include these two items in the analysis, the resulting coefficient of prediction is only moderately reduced (0.810). This confirms the presumption that in face-to-face teaching it is mainly the personal quality of the instructor, which determines the overall assessment of the quality of the course by the student.

Statistical Analysis of the E-Learning Environment

The second statistical analysis concerns the evaluation of the MAS-data, which was gained from the e-learning environment. The theoretical model was the same as described in chapter 2. In this case, each of the following statistical statements is based on a sample of approximately 1000. The same linear regression model was used. We again admitted all predictor variables (questions 1-11); the resulting regression model included questions 6, 2, 4, 1, and 3 in descending order of importance for determining the outcome of the dependent variable (question 12). The overall coefficient of determination amounts to 0.892, again indicating an excellent fit of the model. The result may be interpreted in the way that – contrasting to the situation in a face-to-face environment – it is only the course-related aspects, as analyzed by questions 1 to 6 (and 11) which determine the evaluation of the course by the students.

The results in 3.2 and 3.3 are not really surprising, but they yield an impressive quantitative confirmation of a (possibly vague) conjecture.

Results form the Content Analysis

In addition to the statistical analysis, the content analysis is the second measurement method. In the evaluation process there are two steps to describe the quality in a verbal form. The student can describe the trainer and the curriculum in verbal form. In the 90th of the last century some software tools supporting the content analysis were developed [Perr01; HeCT01]. Semantic content analysis differs from traditional computerized content analysis because it operates on the referentially integrated, meaning representation of a text instead of a linear string of words. Rather than assessing the thematic orientation of texts based on the frequencies of word occurrences, this new methodology examines and interprets explicit knowledge representations of texts. There are three phases to a semantic content analysis [Mall91]:

- *Text Representation***:** the sentences of a text are syntactically parsed and semantically represented to create meaning-rich text models;
- *Classification:* the political analyst applies recognizers, designed in advance, to classify relational configurations of words in text models;
- *Inspection:* the analyst uses any number of interfaces for inspecting text models to view the classifications.

In the analyzing process the semantic analysis is used. Concerning the content analysis results, just preliminary results can be made. Only question 12 (table 1) is now evaluated. Two evaluation measurements based on the theory of Schön were done. The first measurement was done after the first third of the course, representing the concept of "reflection-in-action". The second measurement was done after the end of the course, thus representing the concept of "reflection-on-action". If the "reflection-in-action" measurement for question 12 was rated with the characteristics of 3 or higher, than the "reflection-on-action" measurement was also rated 3 or even higher. This means, the "reflection-in-action" process has a direct impact on the "reflection-on-action" process.

The two evaluation measurement methods were done for 56 courses. Six courses had a rating of 3 and higher. Four courses showed negative group dynamic effects. The content analysis showed that 2 to 3 students were always describing the instructor with negative statements. The remaining students of the course used an objective description of the instructor and tried to formulate the situation without any emotional statements. However, the position of the opinion leaders had such a high impact on the other students, that the course was in general evaluated with a lower rate.

TELETUTOR AND CONCLUDING REMARKS

In April 2001 *e-learning* magazine asked e-learning users to answer a series of questions about the e-learning use in their organizations (URL: http://www.elearningmag.com, 12-06-01). One question was focused on how the organizations measure the success of e-learning. The result from the respondents was: 72% say they use employee feedback to measure the success of e-learning, 46% say improved job performance, and 44% say by tracking the number of employees who take advantage of online offerings. Slightly more than one third, or 37%, say they look at bottom line results. The survey shows that there is a need for models measuring the success of e-learning initiatives.

The case study done at the "SAP Business School Vienna" showed that the successful launch of e-learning depended highly on our three-dimensional evaluation model. The disadvantage of e-learning lies in the missing face-to-face communication to discuss the contents of the lessons. To guarantee a further improvement of the knowledge transfer quality, we suggest the definition of a "teletutor". The individual communication between the "teletutor" and participants grants the learning process a higher quality assurance. A "teletutor" is an agent with the following job profile:

- He reflects the quality of the learning software and gives feedback to the developer of the software,
- He is an important mediator between learning and application environments,
- He is a problem solver by answering technical questions,
- He is a social agent between the students and should build networks between the students and the instructors. This information can flow into further formation of e-evaluation measurements.

The best e-learning environment can be reached by using a good structured evaluation model (figure 1), which is supported by a "teletutor" who has a decisive bridge function, which can try to compensate distances in the learning process.

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