

# Assessment in E-Learning Environments: A Comparison of three Methods

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**Abstract:** Considering didactics, assessment is necessary to evaluate the learning process and, thus, also of relevance for the e-learning situation. In fact, it is harder and more problematic to realise them within online courses. This paper examines important didactical aspects, such as defining competencies, determining learning objectives and assessing learners' achievements within the scope of e-learning, and, furthermore, it reports about a case study comparing three different assessment methods to each other. In particular, the depicted methods are evaluated in terms of the most relevant factors of the teaching process within the area of adult education.

## 1 Introduction

E-learning can be considered to be highly related to learning and teaching as stated in (Jain et al., 2002). Therefore, pedagogy and didactic are important aspects for all facets of e-learning, reaching from the creation of the courseware and application of an e-learning system to the evaluation of the learning progress. In particular, didactic has a great impact on designing and mediating learning content (e.g. see Gunawardena & McIsaac, 2003). Considering the traditional teaching process, the teacher has to decide which competencies have to be mastered by the students to which extent and how the result of the learning process should be measured. Such considerations are usually realised by determining learning objectives and assessment methods for a course.

With respect to (Mödritscher & Sindler, 2005), applying certain didactical principles can be challenging in the e-learning situation. In particular, assessment can be considered as difficult to be realised within a distance learning phase. Nevertheless, assessing the learning process is necessary in all kinds of educational scenarios, as for example also in the context of adaptive e-learning as pointed out with the macro-adaptive instructional approach in (Mödritscher et al., 2004). In this paper, the assessment of the learning process focuses on the teacher's evaluation and rating of the learners' achievement levels gained through a course.

Being one special and interesting topic for the research project AdeLE (see AdeLE, 2005), this paper reports about a case study carried out at Campus02 (see Campus02, 2005) comparing three different assessment methods within an e-learning course for adult students. Therefore, basic didactical principles about competencies, learning objectives and the assessment of learners' achievement levels are highlighted as a result of literature research. Subsequently, the setup of the case study and the implementation of the three courses providing different assessment methods are described in detail. Finally, the results of the e-learning experiment are analysed and the three assessment methods are compared to each other before concluding the paper.

## 2 Didactical Aspects relevant for the e-Learning Situation

Teaching itself is a very complex process and not fully realisable within e-learning systems (see Spector & Ohrazda, 2003). Thus, this paper focuses on three critical questions when planning and evaluating a course: What competencies should be mediated to the students? To which extent should these competencies be mastered? And how can the results of the learning process be measured after having finished the course?

With respect to didactic, the first important aspect of teaching deals with the kind of **competencies** to be mediated to the students. Regarding Howard Gardner's Multiple Intelligences, (Durand, 1998) describes three main classes of competencies: (1) knowledge being seen as a kind of mental model about parts of the real world, (2) skills being related to the capacity of applying and using acquired knowledge, and (3) attitudes dealing with social or affective aspects. In praxis, a competency is supposed to be related to more than one of these classes. In most cases a strong focus on one class can be recognised, but there can also be adequately mixed competencies.

After considering what should be taught within a course, it is important to decide to which extent and under which circumstances the competencies should be mastered by the students. Therefore, a teacher has to define learning objectives following some kind of taxonomy, for instance the one by (Bloom et al., 1956). For the three domains of competencies described above, the **different levels of objectives** can be summarised by the most

relevant terms given by the Bloom taxonomy. Furthermore, it is possible to define other conditions such as the usage of a tool or the time extent for each objective.

(IDS, 2002) points out the necessity of **assessment** which should be executed not only to grade students, but also to measure the learning process. In addition, the assessment method has a great impact on the students' learning behaviour as stated by (Scouller, 1998). Within traditional educational styles, a teacher determines to examine students using limited-choice or open-ended questions. Limited-choice questions such as multiple choices are applied to reach lower-level objectives like recalling facts. Open-ended questions like sentence completion, short answers, essays etc. require students to formulate their own answers which do not have to be pre-determined. It is easy to see that open-ended questions can be used to evaluate higher-level objectives like applying or evaluating assimilated knowledge. Hence, for certain domains like mathematics, physics or programming exercises, limited-choice questions might work for assessing higher-level objective because students have to apply their gained knowledge to complete a question with a pre-determined answer like some mathematical calculation. Teachers have to consider which type of question they use for assessment depending on the level of learning objectives, size of the class, reliability in grading, prevention of cheating, exam construction and grading time, and several other criteria.

### 3 Restrictions and Implementation of Assessment in the E-Learning Situation

When examining the didactical aspects treated in the last section, the following **problematic areas** for the e-learning situation can be identified:

- All kind of competencies – knowledge, skills, and attitudes – may be mediated within an e-learning environment. Therefore, it is possible to create learning content including facts relevant for a learner, instructions how to achieve a skill, or information about an expected behaviour. Thus, technology can be seen as an enabler for these types of competencies, because information can be enriched with multimedia assets (see Gunawardena & McIsaac, 2003), practicing skills can be supported by using interactive elements or tutoring systems, and the behaviour of a student can be observed within the context of the e-learning system by terms of the micro-adaptive approach for e-learning (see Park & Lee, 2003). In fact, it is easier to mediate knowledge through e-learning environments, while the effort for teaching skills or attitudes is much higher as shown in the case study in the next section.
- Within an e-learning system, objectives need to be defined regarding the target group. With respect to the standardisation process in the field of e-learning, specifications such as SCORM already allow to describe objectives as meta-information for the course (see ADL, 2004). Nevertheless, an objective specified with SCORM can be seen as a state within the system and does not tell anything about the level of the learning objective. Furthermore, it is hardly possible to reach high-level learning objectives for all three types of competencies within a pure e-learning situation as stated in the study later on.
- Learning objectives which are defined by a teacher always have to be evaluated in some way – to grade the students and to improve the quality of the course for future sessions. Considering the possibilities of e-learning, it is well documented that we can assess the gained knowledge by using limited-choice questions like quizzes or multiple-choice questions. Nevertheless, for most areas and, in particular, to reach high-level learning objectives it is necessary to examine students asking open-ended questions, as reasoned e.g. by (Scouller, 1998). Furthermore, the answers to such questions have to be interpreted and evaluated by experts. Researchers try to imitate such expertises using artificial intelligence methods within intelligent tutoring systems, but the results are rather limited yet (see Park & Lee, 2003). In terms of skills, we cannot measure the learning results using technology-based methods without hard efforts.

It has to be outlined that the assessment of high-level objectives can be realised in many different ways. With respect to the assessment methods focusing on didactical aspects such as defining competencies and evaluating the learning process according to the determined learning objectives, the following possibilities for **implementing assessment in the e-learning situation** can be found in the literature:

- First of all, most e-learning systems offer the possibilities to create and provide limited-choice questions. Although quizzes can save a lot of time to grade a large amount of students and (Scouller, 1998) reports about good results for low-level objectives of the cognitive domain, they show a worse performance for the employment of deeper learning strategies and higher levels of cognitive processing.
- Therefore, it is necessary (see Scouller, 1998) to implement open-ended questions within the e-learning situation, for instance by tasks like writing essays or submitting some sort of project work. It is obvious that the evaluation of such tasks is extremely time-consuming for a teacher. Therefore, it is recommended to apply supporting methods such as automated grading, e.g. using the Markit<sup>®</sup> system introduced in (Williams & Dreher, 2004).

- As an extension of automated essay grading, Intelligent Tutoring Systems (ITS) may provide some kind of expertise within a domain and allow fully automated teaching and assessment, as stated in (Park & Lee, 2003). Yet, this kind of systems is hard to realise, often restricted to a certain domain and, thus, to a few learning objectives. An example for a rather complex system in this area is INCENSE providing different scenarios for teaching the software engineering process (see Akhras & Self, 2000).
- (Lennon & Maurer, 2003) describe several approaches beginning with the usage of professional authoring software up to a shift to the constructivistic learning paradigm. On the one side, automatically generated crossword puzzles may be enabler for the students' interest and motivation and have positive effects on assessing low- to medium-level objectives of the cognitive domain. On the other side, applying constructivistic learning methods is requiring a high level of students' self-motivation, but can reach high-level objectives in all domains as shown in the next few paragraphs.
- One aspect of constructivism deals with collaborative learning. In particular, group activities requiring students to discuss a topic are a powerful element to extend the possibilities of e-learning as outlined by (Piaget, 1977). For instance, students may treat open-ended questions, when they are working in groups.
- Another interesting concept of constructivism is a so-called peer assessment, which was applied as one assessment method in the case study comprised in the next section. As described in (Bhalerao & Ward, 2001), peer assessment may reach high-level objectives for all possible domains and provide other advantages, such as using natural language processing, lowering the effort for the teacher, etc.
- Finally, (Gredler, 2003) reports about games and simulation in the e-learning situation which can also be seen as a solution to reach high-level objectives, in particular for intellectual skills, but also for mediating knowledge or internalising value systems.

#### 4 Setup of the Assessment Strategy for the E-Learning Study

Due to the depicted possibilities of assessment for e-learning, this section reports about a study comparing different assessment methods within online courses. The study introduced in this paper was realised at the Graz University of Applied Sciences Campus02 and describes an online course about the topic "document formats" within the area of adult education. The course carried out over a period of two month was realised according to a full virtual concept using a customised version of the e-learning platform Moodle.

Although the course deals with basics of information technology, attempts were made towards reaching the whole set of competencies and even some higher levels of objectives. Characterising the e-learning course with reference to Bloom's taxonomy, the **learning objectives** comprise five "Level I", four "Level II", and two "Level III" objectives of the cognitive domain, two "Level III" objectives of the psychomotor domain as well as one "Level III" objective of the affective domain (see table 2 in the next section). To compare the different assessment methods, three e-learning courses were implemented and each student was assigned to one of these courses according to the achievement levels of a topic-related lecture. The courses are characterised in the following ways:

- Course A was planned with respect to **Behaviourism**, whereat learning objectives and materials were portioned into three modules by the teacher and each student had to study a module and finish with an online examination to measure the students' achievement levels. Furthermore, this course included some playful activities, such as several attempts in the exam, an increasing difficulty level, a task to gain a bonus, etc., to keep the learners motivated. The learning process was assessed by typical behaviouristic elements like multiple-choice questions, assignment tasks or short answers. To examine the high-level objectives of the psychomotor and affective domain, ITS methods were simulated by the teacher, e.g. by manually evaluating the submitted strings encoded by Huffman or LZW.
- Course B was implemented according to the ideas of **Cognitivism**. Therefore, the tasks can be characterised by classical cognitive elements, for instance repeating learning content in different ways, working out parts of the course within a group work or re-structuring the content. This course was divided into two phases: Firstly, three groups consisting of four students each had to work out a part of the overall objectives. In the second phase, the groups were reassembled to four groups with three group members while each group had to restructure the results of the first phase using a WIKI environment. To motivate the groups, the best work of the second phase was awarded with a bonus. To assess the learning process, the results of each phase were graded by the teacher based on the quality and quantity of the students' work within the group. WIKI enables the reproduction of the student's part within the group.
- Course C comprises the idea of **constructivistic learning** and was realised by simply giving the student groups all materials and the task to create a work about the objectives of the course. In the second phase, the three members of each group had to compare the works of the other groups and evaluate them by

distributing a certain amount of points and reasoning the distribution. Again, the group with the best work received a bonus. The group works were graded by the teacher on basis of the peer reviews.

While the e-learning phase was in process, students were instructed to document certain aspects, such as the effort for learning, a self-assessment on reaching the objectives, and the learning materials used. Furthermore, an unannounced and challenging examination as well as a post-questionnaire had to be carried out in the course of the lecture held after the e-learning experiment. Based on the whole amount of data retrieved from this e-learning experiment, the next section summarises the experiences gained about assessment in the e-learning situation.

## 5 Comparison of the three Assessment Methods

Evaluating the assessment methods within the three courses described in the last section, the comparison of the methods focuses on different aspects in these three stages: planning, implementing, and concluding the courses.

<b>I) Teacher's activities and effort (planning stage)</b>	<b>Course A</b>	<b>Course B</b>	<b>Course C</b>
1. Determining organisational parameters	1 <sup>*)</sup>	1 <sup>*)</sup>	1 <sup>*)</sup>
2. Defining the learning objectives	1 <sup>*)</sup>	1 <sup>*)</sup>	1 <sup>*)</sup>
3. Preparing the existing materials	2 <sup>*)</sup>	2 <sup>*)</sup>	2 <sup>*)</sup>
4. Assigning students to the three courses	½ <sup>*)</sup>	½ <sup>*)</sup>	½ <sup>*)</sup>
5. Creating instruction and a form for the ongoing evaluation	½ <sup>*)</sup>	½ <sup>*)</sup>	½ <sup>*)</sup>
6. Creating instructions and activities for the course	5 ½	1 ½	1 ½
7. Preparing concluding tests and post-questionnaire	2 <sup>*)</sup>	2 <sup>*)</sup>	2 <sup>*)</sup>
<b>Teacher's overall effort for the planning stage [in hours]</b>	<b>12 ½</b>	<b>8 ½</b>	<b>8 ½</b>
<b>II) Teacher's activities and effort (implementation)</b>	<b>Course A</b>	<b>Course B</b>	<b>Course C</b>
1. Introducing the online course in the lecture	1 <sup>*)</sup>	1 <sup>*)</sup>	1 <sup>*)</sup>
2. Weekly mail to inform and motivate students	2	1	1
3. Supervising the group tasks	-	1 ½	½
4. Individual feedback on student tasks and group works	2	1	½
<b>Teacher's overall effort for the implementation [in h]</b>	<b>5</b>	<b>4 ½</b>	<b>3</b>
<b>III) Teacher's activities and effort (concluding stage)</b>	<b>Course A</b>	<b>Course B</b>	<b>Course C</b>
1. Assessment of learning process and grading	½	2	1
2. Concluding exam and post-questionnaire	2 <sup>*)</sup>	2 <sup>*)</sup>	2 <sup>*)</sup>
<b>Teacher's overall effort for the concluding stage [in h]</b>	<b>2 ½</b>	<b>4</b>	<b>3</b>
<b>IV) Further Characteristics</b>			
Students' self-assessment of average effort [in hours]	12.2	9.4	7.6
Students' self-assessment of mastering objectives	92.9%	46.8%	74.3%
Results of assessing the running course	78.1%	78.9%	79.9%
Results of the concluding exam	54.8%	37.4%	43.2%

**Table 1: Characteristics of the three courses for each stage and overall (<sup>\*)</sup> all courses alike)**

First of all, the planning stage took the lecturer approximately 16 hours distributed as shown in table 1 (section I). Including the effort of seven hours for course-independent activities, the teacher spent more time to create course A than to prepare the courses B or C. These differences can mainly be reasoned by the high effort for creating questions within Moodle. Second, the implementation of the courses except the assessment and the concluding evaluation required an amount of 11.5 hours of work from the teacher. An overview on the teacher's activities and efforts for carrying out each course is given in table 1 (section II). Finally, the concluding stage of the e-learning phase took the teacher about 5.5 hours distributed as pointed out in table 1 (section III).

Analysing further characteristics from table 1 (section IV), students of course A meant to master most of the 14 learning objectives, while students of course C doubted about it, and students of course B were very pessimistic about the achievement of the defined competencies. The results of the ongoing assessment were rather equal due to a very moderate grading to keep the students motivated. In fact, the results of the unannounced and demanding concluding exam consisting of one question for each learning objective are more reliable and allow evaluating the effectiveness of each course, which is strongly related to the students' self-assessment of mastering the objectives.

Considering the efforts for each course, it has to be stated that the most time-consuming course for both the teacher and the students was course A. Besides, only the grading was fast and easy in this course due to the usage of Moodle's quizzes module. Course B demanded fewer from both the teacher and students, even though the grading was more complex. Since the students of this course spent a great amount of time on the tasks, it was obviously not

very effective to use the WIKI module for extensive group works – the students considered themselves to be more concentrated on the tool than on the learning content. Course C is characterised by the lowest effort for all aspects except the grading of the group works. In contrary to course B, the peer review task supported the teacher in grading and assessing the learning process.

Nr	Objective	Type/ Level	Attempted (Overall, Course A/B/C)	Mastered (Overall, Course A/B/C)
1	Overview about scientific working	K/1	<b>64.9%</b> (64.3%/81.8%/ 50.0%)	<b>50.9%</b> (57.8%/58.6%/35.8%)
2	Valuing given citation rules	A/3	<b>24.3%</b> (28.6%/18.2%/ 25.0%)	<b>9.0%</b> ( 8.6%/ 9.8%/ 9.0%)
3	Comparing layout- and structure-oriented formats	K/2	<b>37.8%</b> (28.6%/36.4%/50.0%)	<b>23.3%</b> (19.3%/14.7%/35.8%)
4	Overview about text-oriented formats	K/1	<b>94.6%</b> (92.9%/90.9%/ 100%)	<b>73.2%</b> (81.3%/64.5%/71.7%)
5	Reasoning facts of text-oriented formats	K/3	<b>91.9%</b> (85.7%/100%/ 91.7%)	<b>83.5%</b> (81.3%/86.0%/83.7%)
6	Explaining colour models	K/2	<b>32.4%</b> (35.7%/18.2%/41.7%)	<b>17.1%</b> (30.0%/ 4.9%/13.4%)
7	Overview about halftone images	K/1	<b>83.8%</b> (100%/ 63.6%/83.3%)	<b>60.0%</b> (73.8%/45.2%/57.3%)
8	Explaining compression algorithms	K/2	<b>78.4%</b> (85.7%/81.8%/66.7%)	<b>42.1%</b> (57.8%/34.4%/30.8%)
9	Applying compression algorithms	S/3	<b>21.6%</b> (42.9%/ 9.1%/ 8.3%)	<b>9.2%</b> (19.3% / 3.2%/ 3.0%)
10	Comparing graphical formats	K/2	<b>89.2%</b> (92.9%/81.8%/91.7%)	<b>60.8%</b> (72.8%/41.9%/64.2%)
11	Overview about digital audio	K/1	<b>89.2%</b> (92.9%/81.8%/91.7%)	<b>60.6%</b> (65.3%/48.4%/66.3%)
12	Overview about digital video	K/1	<b>81.1%</b> (92.9%/72.7%/75.0%)	<b>57.2%</b> (79.2%/38.7%/48.6%)
13	Designing an information system for different document formats	S/3	<b>78.4%</b> (85.7%/72.7%/75.0%)	<b>58.3%</b> (72.8%/51.6%/47.5%)
14	Reasoning the application of document formats in information systems	K/3	<b>70.3%</b> (64.3%/72.7%/75.0%)	<b>37.0%</b> (48.2%/21.5%/38.1%)

**Table 2: Objectives, competencies according to the Bloom Taxonomy (Type: Knowledge, Skill, or Attitude; Level: 1-6), and the rates of attempts and successful achievements (overall and for each course)**

Analysing the answers of the concluding exam (see table 2), it can be stated that most of the students attempted the questions about the objectives of the cognitive domain and especially about the low-level objectives, while only a few students tried to answer the question about the objective of the affective domain and, further, very few of them answered it correctly. Hence, this does not really guarantee that the students really adopted the defined behaviour. Similarly, the questions to the two objectives of the psychomotor domain were avoided by most of the students. In particular, 8 out of 38 students tried to apply the compression algorithms that is 6 of course A, 1 of course B, and 1 of course C. Although this question was much easier than the tasks in the online courses, none of these 8 students could answer it absolutely correctly.

By interpreting the results of the three online courses, it is important to define learning objectives and to compel the students to deal with each objective. The more a student is forced to treat each objective on his own the better the self-assessment on being able to master this objective as well as the performance on an exam is. In particular, course A worked very well, because each student had to work alone on each objective. Nevertheless, course C showed excellent results due to the risk that constructivistic learning might not work for all students. Thus, it has to be mentioned that the second task, the peer review of the other group works, was mainly responsible that each student treated each objective at least two times. Course B performed very weak as a result of a severe didactical problem. It was possible for a student to leave out objectives within the two phases of the group tasks.

## 6 Conclusions and Outlook

To summarise this paper, the necessity for didactical aspects such as defining competencies, determining learning objectives and implementing assessment methods can be considered as very essential for online courses, although these basic didactical elements may be problematic within the e-learning situation. As it was shown in the case study, the assessment and the grading should not be realised by only using quizzes. There are several other ways to assess the learning process, which might work better or worse for defined objectives. In fact, mediating objectives of the psychomotor or affective domain through e-learning is always more extensive and might not be assessable in online courses. Furthermore, it is also very hard to reach high-level objectives for all kinds of competencies within pure technology-based learning and teaching.

The study carried out within the scope of adult education pointed out, that objectives of all sorts of competencies up to the third level can be realised in online courses by applying different methods. Firstly, the Behaviouristic approach seems to be very effective, but also time-consuming for the teacher and the students, even though grading was fast and easy. Secondly, the teaching method following the Cognitivism was ineffective due to a strong focus on using an e-learning tool. Nevertheless, preparing and running the course was not that time-consuming than the first method. Thirdly, the constructivistic approach showed good effectiveness in learning results and low effort for the teacher and the students. Overall, it is recommended to determine the assessment method with respect to the priority of a learning objective. With respect to the AdeLE research project, these findings should be considered for the adaptive e-learning environment.

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