ANALYSIS OF E-LEARNING SOFTWARE AND GUIDELINES FOR QUALITY ASSURANCE IN PHOTOGRAMMETRY, REMOTE SENSING AND GIS

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Commission VI, WG VI/2

KEY WORDS: Education, Evaluation, Learning, Quality, Teaching, Web-based

ABSTRACT:

ISPRS funded the short-term project "Analysis of e-learning Software and Guidelines for Quality Assurance in Photogrammetry, Remote Sensing and GIS" which was carried out by the authors. Their work aims to make the existing offers in e-learning more transparent. Available learning software related to Photogrammetry, Remote Sensing and GIS has been identified and classified according to its content and other criteria, among which quality is the most important. Therefore, the paper discusses quality of e-learning and defines common criteria by which to 'measure' e-learning quality. Emerging from this discussion, relevant criteria for the evaluation procedure have been defined in a criteria list. Such a criteria list is a normative-static assessment tool that made it easy to evaluate a wide range of learning arrangements within a short period and without time consuming empirical studies in advance. The criteria list includes not only aspects of content, level and didactic approach, but also design, quality of instruction, quality of implementation, usability, accessibility and availability, up-to-dateness, completeness, etc. 30 e-learning products have been evaluated according to the identified criteria. The paper presents the results and summarizes trends in quality of current e-learning. Since evaluation should be as much objective as possible, an online-survey was prepared. We introduce this environment and ask readers for participation.

1. INTRODUCTION

During the last decade e-learning in Photogrammetry, Remote Sensing and GIS faced a shift in the way of using media by developing e-learning products in a highly motivated manner. Although many new e-learning materials are now available, their existence often is unknown, even in our community. Further, content and design vary in quality and up to now no institution could support people who are interested in using e-learning courses for gaining up-to-date knowledge in our field of work.
The project "Analysis of e-learning software and guidelines for quality assurance in Photogrammetry, Remote Sensing and GIS" aimed at bringing transparency in terms of these issues.

2. APPRAISAL OF CURRENTLY AVAILABLE E-LEARNING OFFERS

One of ISPRS Commission VI's main tasks is to promote education and training. This includes giving publicity to currently available offers in Computer-Assisted Teaching, resp. Learning, as promoted at Commission's webpage of 'Educational pointers, Tutorials, Proceedings and Software' (http://www.isprs.org/links/tutorial.html).
'E-learning offers' (resp. material/ products etc.) are actually a heterogenous compound related to learning. Anderson & McCormick (2006) distinguish e.g.:

- Information/ data for and about learning,
- Learning objects,
- Authentic online research resources,
- Models and simulations,
- Tools for e-learning applications,
- Computer technology-based learning support,
- User guidance materials and
- Course packages.

The emphasis of this study is mainly placed to learning objects, models and simulations as well as course packages, i.e. products directly transferring content. Subsequently some information/ data for and about learning, online research resources and user guidance material are included. Tools for e-learning and computer technology-based learning support are not considered. Also pure software developments presented under the title of e-learning are excluded unless they are embedded in a proper lesson about the task or used for illustration and/ or practical experience. Due to the remarkable variety of offers the classification (as well as the targets of this analysis in general) has been restricted to web-based e-learning products. This includes only (freely available) open source material available on the web.

To provide a clear overview, a classified and updated list has been put to Commission VI/ WG2's webpage (http://www.igg.tu-berlin.de/ISPRS/quality/overview.php). This list is augmented by criteria-based search functions.
Assche & Vuorikari (2006) presented criteria by which users select learning resources, e.g. does a learning resource fit to participant's learning settings attitudes Is the level of difficulty appropriate? Does it contribute sufficiently to the pedagogical goals? I.e. Are prior specialized knowledge and learning targets identified? Are examples given? etc.

To answer most of the questions above four main criteria are determined for classification: content, target group, producer and setting.
Depending on the kind of implementation following settings are distinguished:

- Text,

- Text with interactive assets,
- Text with tests and feedback,
- Power Point Presentation,
- Audio/ Video,
- Animation/ model/ simulation,
- Software for off-line use,
- Software for on-line use,
- Map exercise,
- Virtual Landscape and
- AR-Environment.

30 e-learning products aiming at students but also at the interested public are analyzed. Most of the material and software has been produced mainly in the scientific environment, but also are developed in commercial or governmental institutes. Text-based material is predominant.

3. QUALITY OF E-LEARNING

To determine a quality model for e-learning it is important to know by which aspects of e-learning the learning process in general will be improved.

The „e“ in e-learning brings the already often cited advances concerning time- and spatial-*independent* access to learning environments. Furthermore delivery of diverse *media* and resources through the internet opened a completely new way to transfer content. Not only the way of transferring content, also the kind and level of content to be transferred changed to better *use of distributed data*. *Access to worldwide data* and materials enables a better *international discussion* on content, but also on the way of learning and on curricula. Hence quality in terms of different facets of learning improves.

Incorporating a higher level of *interaction* and *dynamics* may be realised with the e-technologies. Dynamics is meant in terms of reaction on user's needs, a point discussed in more detail in the section below. *Communication* is another advance of e-learning. Aspects like media, interaction and communication bring a higher level of *joy* to the user. Since joy is often related to games it owns the aftertaste of being not a helpful emotion. But it fosters *motivation* that improves attention and effectiveness in learning. "Edutainment" is the term describing this phenomenon.

If implemented in a reasonable and well-matured way e-learning environments may bring *advances in terms of economical aspects* (which requires clear objectives and a distinct conceptional design).

All these aspects are part of the common "e-Hype" which calmed down to a rather unemotional level in the previous years. However it is important to assure quality in terms of these aspects, since they are crucial features in e-learning.

The big chance of e-learning lies in the challenge to move from the traditional method of teaching to a more user or learner centred approach. This implies a shift from the rigid teacher – pupil transfer of knowledge to a dynamic learner-centred vision or from behaviouristic to constructivist learning theory (see Katterfeld et al., 2007). Consequently the focus is not set to the plain delivery of material than rather on tools of interaction, communication and collaboration. The learner acquires and compiles the knowledge himself. The learner is demanded to assume responsibility for his own learning. Teachers act as tutors, comparable to guides in the learning process. E-learning environments may – if accordingly designed – cover the needs of *constructivist learning by taking the learner and his needs into the centre*.

Learning paradigm which drafted in that way must – within a quality discussion – additionally to the well-known aspects (*content* and – subordinated – *technology*) pay attention mainly on the

- learning process and
- key actors involved.

Ehlers & Pawlowski (2006) call these *actors* the most important dimension within the quality assessment process.
Three levels of quality for the education process – the so-called quality triad by Donabedian (1980) – are also helpful in the assessment for e-learning:.

- E-learning prerequisites (input or structure quality),
- The learning process (process quality) and
- The result (output/ outcome quality).

Layte & Ravet (2006) ask in a similar way: Who has learned? The answer leads to the aspect of input quality. What has been learned – and how? This question covers the process quality. And conforming to the outcome quality: What is the impact of the learning activities?

The first level (input quality) covers things like availability or capability of technological infrastructure. These important aspects are well known from former discussions on quality as well as from fixed standards for e.g. learning technology or metadata.

However the second level, which includes the interaction of the learners, learning formats, learning culture, learning content or training goals is crucial and accords to the learner-centred view discussed above. The assessment of e-learning quality must incorporate these factors, which represent the learning process itself. The here presented work tries to meet that goal by including appropriate criteria.

The third level – the outcome quality – gives probably the best information on quality of resources. Since learning aims for knowledge, awareness and ability, a well or excellent result in these competencies may – independent of all theory – legitimate any resource. In short: The end justifies the means.
However it is hard to assess the outcome. A standardised investigation with a significant number of test persons, possibly with different learning scenarios would be needed. But this is very costly. Outcome is hard to assess due to the complexity of different scenarios. How to assess e.g. diverse pre-knowledge, how to test and assess abilities not expressed as hard facts?

In the context of this short-term study a detailed evaluation goes beyond the scope. It is obvious that the presented ideal is very much influenced by prevailing interests, concepts and dominant theories or even culture. Any overall definition of quality in e-learning runs the risk of constraining people's vision of what quality means and its significance in their particular context (Dondi et al., 2006). Thus quality remains a negotiable, not clearly to outline issue. If quality is defined it must be accepted as normative act done within a certain context. Also Hildebrandt & Teschler (2006) believe that quality approaches for e-learning are just abstract conceptualisations of "good e-learning" and thus no consistent descriptions of them are available. Hildebrandt & Teschler (2006) present a concept,

which deals with different quality approaches. Their so-called European Quality Observatory (EQO) Analysis Model tests quality approaches for their characteristics. More details can be found also on the web page (http://www.eqo.info). However the authors like to adopt the idea that different (acceptable) definitions of quality are available as third working level into our study (see section 6.2).
However they propose an assessment system that gathers diverse opinions on either (including the third) level. Due to manifold subjectivity it can be assumed to achieve a more unbiased view (see section 6.2).

Within the first level e-learning will be evaluated in terms of the described quality approach. Theoretical considerations to that topic are presented in chapter 5. Chapter 6 accounts for the course of action within this approach.

4. METHODS TO ASSURE QUALITY

The previous chapter pointed out what could be expected – in an idealised way – from valuable e-learning. Hardly any offering will match all demands. However the authors strive for assurance of good to excellent quality in the overall instance.

Quality may basically be ensured by three main groups of methods (cp. Ehlers & Pawlowski):

- Quality Management approaches,
- Quality Assessment approaches and
- Evaluation methods.

4.1 Quality Management Approaches

Quality management approaches in general aim to ensure the quality of educational processes. They do not focus so much on products or materials than on the creation and implementation processes.

For e-learning there are currently no generally recognized quality management approaches available. Concepts are increasingly being developed. (Ehlers & Pawlowski, 2006)

4.2 Quality Assessment Approaches

Quality assessment approaches in (higher) education are e.g. checks based on criteria lists, benchmarking, audits, accreditation and certification as well as quality marks awarded by special organizations.

Benchmarking is an analysis process based on the comparison of products (e-learning offerings) referring to specific criteria.
An *audit* can be defined as a method for assessing the strengths and weaknesses of the quality assurance mechanisms, adopted by an institution for its own use in order to continuously monitor and improve the activities and services of a subject, a programme, the whole institution, or a theme.
Accreditation and c*ertification* works in the way that providers of e-learning submit their material or offerings to one-time or regular audits and are then awarded or certificated by an organisation. It thus is a method of external review based on self- and peer assessment, mostly applied for higher institutions.

Quality Marks are self-developed marks of quality, which are awarded by a well-accepted organisation to their members at fulfilment of defined criteria. Quality marks mostly cover only certain aspects of quality. Hence it should be proved that a special mark addresses the demands of the user.

A relevant and popular way is the use of a c*riteria checklist*. The criteria are developed as the translation of the postulation of an aspired quality model into practical or subsumable characteristics of the material. By this they enable people to assess, develop or select learning environments. The development of a criteria checklist is one significant task of this analysis. This topic is described in chapter 5 in detail. Based on this list E-learning offerings are tested to what extent they meet the criteria.

Both working steps are to some degree subjective. For some quality criteria no explicit validity prove exist, but they are simply assumed to be effective for learning (Ehlers & Pawlowski, 2006). Chapter 5 gives arguments for the validity of perceptions and why distinct criteria have been chosen in the presented analysis. Section 6.2 further on describes an attempt to overcome subjectivity.

Meier (1995) points out that many criteria lists mainly contain criteria from the area of “screen interface design” or “technical usability”. However pedagogical/ didactic criteria are often underrepresented. Meta-studies on learning effectiveness of multimedia learning environments show that in particular the didactic concepts have a greater effect on the learning process than the so-called “delivery technology” that is used (see Weidemann, 1997; Kulik & Kulik, 1991; Kulik, 1994). To overcome this deficit a group of criteria referring to didactical aspects is included.

Although criteria checklists are normative-static tool their use is very favoured. The advantages over empirical methods are:

- that a big amount of material may be evaluated in a relatively short time,
- evaluation results are comprehensive, transparent and traceable.

Existence or absence of quality criteria may be regarded as a characteristic attribute of an e-learning offering and by these criteria are related to metadata. Section 4.4 deals with this task.

4.3 Evaluation Methods

‘Evaluation’ is often used as a general term for the procedure of quality assurance. Evaluation methods do usually not aim for single variables or products than rather for a (learning-) situation or process and thus puts the learner in the focus of attention. Therefore the evaluation approach should be based on a learning theory to better assess the effects of (learning-) processes and the impacts of media.

Evaluation may be carried out by e.g. *empirical studies*, where either an expert or a representative number of persons test the learning environment in a “real-live” situation. The quality is assessed based on the profit of learning as well as on the experiences (concerning handling the material) made by the learner.

Strictly speaking, the assessment of e-learning products using criteria lists (as described in section 4.2) may also be regarded as a form of quality evaluation – a so-called expert assessment. However, since it differs from the more process-related approaches of evaluation in respect of concepts and implementation, both types – quality assessment based on

criteria checklists and evaluation – are considered separately (Tergan, 2004).

5. CRITERIA CHECKLIST

The choice of criteria used for the checklist applied in this study is oriented at the Reference Quality Criteria Catalogues for e-learning (QCC-eL - Berger & Rockmann, 2006) as well as on the 'Framework for E-learning Quality' by Anderson & MacCormick (Anderson & McCormick, 2006).

The QCC-eL is part of a technical specification for open interfaces (the Public Available Specification (PAS) 1032-1 of the German Institute for Standardization), and also annexed to the ISO Standard ISO/ IEC 19796-1. The criteria operationalise relevant ISO-standards for software and multimedia user interfaces (e.g. ISO 9241 – principles for dialogues between humans and IT systems; ISO 14915 – design principles for multimedia user interfaces and organisation of content), relevant laws and regulations (e.g. data protection laws, distance learning protection act, ordinance on barrier-free information technology), consolidated empirical findings from relevant scientific areas (Berger & Rockmann, 2006) and incorporate pedagogical/ didactic issues particularly.

The framework for e-learning quality is an overarching analysis, which provides a high-level overview of all relevant quality components. The survey is part of a British initiative to improve quality of e-learning.

Hence the following criteria were identified, which may be grouped in the categories:

- Content
- Didactics
- Economical Aspects
- Learner's requirements
- Organisational Aspects
- Software Ergonomics
- Technology

Table 1 accounts for the criteria in each category. Deeper discussions on the criteria give Katterfeld & König (2008).

6. THE SURVEY METHOD

The importance of evaluation of the learning process (rather than the material) is emphasised and hence demanded by many authors (e.g. Ehlers & Goertz, 2006). However it would be very costly conducting a study based on empirical methods (see chapter 4). Ehlers & Goertz (2006) propose e.g. some option of methods, such as different kinds of interviews (narrative/ orally-standardised/ written/ telephone) or discussion groups, online forum, tracking/ log files, observation or so-called content analysis. These methods generally aim at getting a representative number of experiences by users.

Within the here presented study we could not carry out a broad survey about experiences of users. However we prepared an environment for written interviews online. The interviews/ questionnaires are based on a criteria checklist (see 4.2.). In addition tools to analyse the interviews have been developed.

In total 30 e-learning products have been assessed by the authors. The result of this appraisal is described in the section 6.2. However the authors are aware of the subjectivity of such personal review. Hence an online questionnaire was developed to open the survey to the public. Users who looked into the subjects are asked to participate by filling in the form at http://www.igg.tu-berlin.de/ISPRS/quality/questionaire.php. It is expected to gain more objective evaluation results for e-learning material the more users will participate in future. In order to refine the result, users' evaluation has to be weighted in terms of his/her level of experience in the field as well as on the intensity of study. Therefore weights are introduced as displayed in table 3.

Level of Experience	**Factor**		**Intensity of Use**	**Factor**
Interested Public	0		produced/ designed the material	0
Student in this field	1	x	skipped over the material	1
Experienced in this field	3		worked with some parts of the material	2
Expert/ Professional in this field	5		worked with all parts once	3
			worked with all parts multiple times	5

Table 3. Factors for weighting user's opinion

As discussed in chapter 3 quality remains a negotiable, not clearly to define issue. By defining a significant number of criteria and by describing their optimal characteristics an ideal of e-learning quality is proposed. However likewise learner's context is varying different views on quality are taken into account. Additionally to the

- content orientation → individualistic learner,
- didactic orientation → pragmatic learner,
- result orientation → result oriented learner and
- technology orientation → vanguard learner,

which accord basically to the learner types introduced by Ehlers (2006, see section 5.4) a

- economical/ sustainability view,

is considered, which acts rather in the interest of providers or at the institutional level. All views incorporate the same criteria (see chapter 5), which are however weighted differently. The weighting of each criterion within each view conforms to its relevance as listed in table 2.

Category	**Criteria**	**Description**
Content	Correctness	Is the content correct
	Completeness	Is the content complete
	Relevance of the used material	Is the used material relevant to the issue
	Presentation within a wider context/ Motivation	Has the content been described in a wider context, at least within an introduction to motivate the tasks
	Appropriateness of material	Does the material illustrate the content in a helpful way and is the use of the material (media) adequate to the content
	Composition and organisation	Is the content/ material composed and organised in a meaningful and understandable way
	Qualification of Author/ Tutor	Are authors and tutors qualified in an appropriate way
Didactics	Definition of the learning goals	Is the learning target defined
	Definition how learning goals should be achieved	Is defined, how the learning target should be achieved
	Level of didactical concept	Is an (advanced) didactical concept apparent (are e.g. behaviouristic, cognitive and/ or constructivist principles applied)
	Possibilities for interaction	Are (advanced) functionalities for interaction (not only navigation!) available
	Exercises/ Tests	Are exercises and tests available in a meaningful way
	Assessment	is assessment given to exercises and tests
	Individual learner support	Is individual learner support assured (e.g. by possibilities for (regular) contact and/ or individual assessment)
	Possibilities for communication	Are communication options to the tutor and/ or to other learners available
	Design of instructions	Are meaningful instructions for use of material and exercises given
	Qualification of Tutor	Are tutors qualified in an appropriate way
Learner Context	Learner Context	is the learner context (target group, learner type, motivation, previous knowledge/ skills, preferences for interaction) relevant
	Possibilities for Personalisation/ Adaptation	Are possibilities for personalisation/ adaptation given
Organisational Aspects	Fit to curriculum	(in case of students as target group:) does the content of the offer fit to a curriculum
	Certification	(In case of successful accomplishment:) is a kind of certification provided
	Maintenance	Is the maintenance assured
	Quality assurance	Is the quality of the material assured
	Description by metadata	Does a description by standardised metadata in terms of technique, content and organisational aspects exist in a good quality
	Documentation and manuals	Is the material well documented (in terms of organisational aspects, learner orientation and technical use)
Software Ergonomics	Graphical Design	Does the graphical design contribute to comprehensibility and is pleasant in general
	Content Design	Does the design of the content contribute to comprehensibility and is pleasant in general
	User Guidance	is the user guided in a clear way
	Help Functions	Are help functions (in terms of content, guidance and technique) available
Sustainability/ Economical Aspects	Cost-Effectiveness	Is the learning environment developed and operating under cost-effective circumstances
	Funding Strategy	does a sustainable funding strategy exist
	Sustainability	Have actions for sustainability been taken
	Conformance in terms of (interoperability) standards	Is the environment conform to interoperability standards
Technology	Technical Setting/ functionalities	Is the technical setting (including the provision of functionalities) appropriate to the content; are the technical potentials for teaching the issue exploited
	Infrastructure Requirements	What kind of infrastructure (server-/ client applications, peripherals) is provided and/ or required
	Documentation of technical use	Are documentation for the technical environment given (if necessary)
	Ease of use	Is the environment easy to use and plain
	(technical) Quality of assets	Is the quality of assets well
	Up-to-dateness	Is the environment up to date
	Availability	Is the environment available anytime anywhere
	Qualification of Producer/ Designer	Are producers qualified in an appropriate
Learner's Reaction	Learner's reaction	How the learner felt about the training or learning experience

Table 1. Criteria

Category	**Criteria**	**Content Orientation** (Individualist Learner)	**Didacticial Orientation** (Pragmatist Learner)	**Result Orientation** (Result oriented Learner)	**Technology Orientation** (Avantgardist Learner)	**Economic/ Sustainabiliy**[1] (Provider, Institutional Level, Investors)
Content	Correctness	*****	*****	*****	*****	*****
	Completeness	*****	*****	*****	*****	*****
	Relevance of the used material	*****	***	***	***	***
	Presentation within a wider context/ Motivation	***	***	***	***	***
	Appropriateness of material	*****	***	***	***	***
	Composition and organisation	*****	*****	***	***	***
	Qualification of Tutor	*****	***	***	***	*****
Didactics	Definition of the learning goals	*****	*****	*****	***	*****
	Definition how learning goals should be achieved	*****	*****	*****	***	*****
	Level of didactical concept	*	*****	***	*****	***
	Possibilities for interaction	*	*****	*	*****	***
	Exercises/ Tests	***	*****	***	*****	***
	Assessment	***	*****	***	***	***
	Individual learner support	*	*****	*	*****	***
	Possibilities for communication	*	*****	*	*****	***
	Design of instructions	*****	*****	*****	*****	***
	Qualification of Tutor	*****	*****	*****	*****	*****
Learner Context	Learner Context	*****	*****	***	***	***
	Possibilities for Personalisation/ Adaptation	*****	*****	*	*****	***
Organisational Aspects	Fit to curriculum	*****	*****	***	***	*****
	Certification	*	*	*	*	*****
	Maintenance	***	***	***	***	*****
	Quality assurance	***	***	***	***	*****
	Description by metadata	*****	*****	***	*****	*****
	Documentation and manuals	*****	*****	***	*****	***
Software Ergonomics	Graphical Design	*****	***	***	*****	***
	Content Design	*****	***	***	*****	***
	User Guidance	*****	*****	*****	*****	***
	Help Functions	*****	*****	*****	*****	***
Sustainability/ Economical Aspects	Cost-Effectiveness	*	*	*	*	*****
	Funding Strategy	*	*	*	*	*****
	Sustainability	*	*	*	*	*****
	Conformance in terms of (interoperability) standards	*	*	*	*	*****
Technology	Technical Setting/ functionalities	*	***	*	*****	*****
	Infrastructure Requirements	***	***	***	*****	*****
	Documentation of technical use	*****	*****	***	*****	***
	Ease of use	***	***	***	*****	***
	(technical) Quality of assets	***	***	***	*****	***
	Up-to-dateness	***	***	***	*****	*****
	Availability	***	***	***	*****	*****
	Qualification of Producer/ Designer	***	***	***	*****	*****
Learner's Reaction	Learner's reaction	*****	*****	*****	*****	***

Table 2. Relevance of criteria in terms of different quality approaches

[1] In terms of economical aspects all criteria are relevant, since best quality in all dimensions is the best investment in sustainability. However the authors tried to grade between and within the different view points.

7. ANALYSIS AND RESULTS

7.1 Presentation of Results

The presentation of the results may be accessed via web at http://www.igg.tu-berlin.de/ISPRS/quality/advanced_eval_project.php.
The search does not only allow for selection of target group, content and setting but also for a view on quality. The results are listed according to their score in terms of the main criteria (view) and a summarized score of the other four criteria. This summary is calculated by the median of the values assigned to these perspectives.

As an additional tool for presenting results to the interested user, the "Calculate Statistics"-page was developed (see http://www.igg.tu-berlin.de/ISPRS/quality/statistics.php). All submitted questionnaires are analysed online and lowest, highest and average values for the 42 evaluation criteria are calculated and presented graphically. This gives an insight into the current status of e-learning products.

7.2 Summary

The statistics show:

- good to very good results in the content category,
- average to good results in the didactics category,
- poor to average values in the learner context category,
- heterogeneous, but mainly good results with the organisational aspects
- good results in the software ergonomics category,
- average values for sustainability and
- good to very good results in the technical section.

The good to very good values in the content and technical category are not surprising. The content is mainly provided by higher education, research institutes or specialised companies. The considered areas have a high affinity to web- and software-technologies and hence much experience with ergonomics.

However web technology is not used effectively in the realisation of e-learning software. This is disappointing to a certain amount. Criteria like 'Possibilities for Interaction' (74%) and 'Tests and Exercises' (69%) reached certainly good values. However demands were not very high for these important criteria. The authors resigned from differentiating from the beginning, since implementations were (unfortunately) observed to be not very sophisticated. The very average values concerning 'Assessment Tools' (which only tested the existence of tools) are evidence that the application of more detailed criteria in the field of interactivity would result in a comparatively poor review.

In the didactics category a backlog demand concerning interaction, explicit definition of learning goals (67%), definition how learning targets should be reached (48%) and design of instructions (65%) have been identified. In general more conformances to the constructivist ideas are demanded.

In the 'learner context' category it has only been tested if the context situation of the learner (in any form) has been considered. Of course implicitly e.g. level and affiliation to a target group of the learners are assumed and served by the material (and were hence evaluated positively). However more explicit account would be helpful. Differentiation in the material according to learner's context would be even better in the sense of learner-orientation. Existence of possibilities for personalisation is the best realisation of learner centring. However this criterion reached only a poor score (29%). It is probably not demandable that freely available offers provide such functionalities since they require more sophisticated techniques and maintenance. Courses and material restricted to a certain user group use in general LearningManagement Systems (CMS) and are hence better applicable in terms of personalisation, communication, and support by a tutor. The intense contact to a tutor fulfils the need for feedback, allows individual mentoring, and better carters to the needs of the participants,. In this survey both criteria (contact to a tutor and communication) rate moderately only (50% and 53%) despite the low requirements (in most cases the availability of an e-mail address is rated positive).

Criteria for organisational aspects like certification and description by metadata achieve only poor results. The certification result should not be overestimated, since only freely available products have been tested. However the poor value for 'description by metadata' (24%) is to appraise more negatively. Metadata are either not available at all or do not conform to standards. Surely the cost of creation and maintenance is very high and much disorder exists in terms of standards. But metadata is crucial for sustainability of e-learning.

In the sustainability category most criteria reached good results. However, most criteria could not be checked convincingly. In general the hypothesis may be posted, that sustainability is in reality weaker than the study provides. Only the score of 'conformance to (interoperability-) standard' of poor 29% reflects that situation. However on the non-technical level the tested material lacks of interoperability standards. Surely the effectiveness of such standards is arguable. However from the point of view of sustainability it is worth.

For summary the following issues have been identified:

- Since many criteria in the didactic section only reach average or poor values, the lack of didactical concepts must be mentioned. Hence a more intense occupation with didactics is required. Investments in concepts, elaborated design of instructions and implementation of feedback is crucial.
- Consideration of learning context is mainly underestimated. More differentiation within the material would be helpful to suit diverse learning needs. Aspects also important in the didactic section would help to better focus on the learer, such as user-dependent availability of material, exercises and tests, options for individual assessment or individual support.
- Implementation and – to some degree previously – establishment of (better accepted) concepts for metadata and interoperability.

The three issues mentioned above are not new. However for the current moment the study identified them as focal points for future development and improvement in e-learning.

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ACKNOWLEDGEMENTS

The authors wish to thank ISPRS Foundation for funding the short term project of the same title.