Engineering e-learning surveys: a new approach

S. Campanella, G. Dimauro, A. Ferrante, D. Impedovo, S. Impedovo , M. G. Lucchese, R. Modugno, G. Pirlo, L. Sarcinella, E. Stasolla, C. A. Trullo

Centro "Rete Puglia" – Università degli Studi di Bari - Via G. Petroni, 15/F.1, Bari – ITALY
Dipartimento di Informatica – Università degli Studi di Bari - Via Orabona, 4, Bari – ITALY
Dipartimento di Elettrotecnica ed Elettronica, Politecnico di Bari, Via Orabona, 8, Bari – ITALY

mailto:impedovo@di.uniba.it http://www.retepuglia.uniba.it/Impedovo/index.htm

***Abstract*—** This paper presents a new approach to engineer useful surveys to evaluate quality of e-learning courses. The proposed quality model evaluates not only quality in use but also quality in learning. Questions allow monitoring not only how the learning product results easy to manage, but also estimating how much it is useful for the learning process. The quality of the interface, the friendliness of the contents, the quality of concepts and the capability to transfer new knowledge are all considered. Learner involvement and motivation are considered as relevant factors to measure user satisfaction. The first results, obtained during university teaching activities, show the efficiency of the proposed survey in discriminating the relevant factors.

***Keywords*—** e-learning, learnability, quality evaluation, survey, usability.

I. Introduction

Information and communication technologies are rightly recognized as tools that are radically transforming the process of learning. Universities, Institutions and industries are investing increasing resources to advance researches for providing better and more effective learning solutions. E-learning is becoming one of the most popular solutions to meet new needing.

In e-learning course development and management the emphasis is often on technical aspects, whereas the relevance of learning products for the actual process of learning is not enough considered. Indeed the most important aspect of a learning product is its aptitude to provide knowledge and skill by stimulating an in dept study, further researches and close investigations. The added value of an e-learning activity is in the learning itself and not in the instrument used to vehicle new contents and concepts.

The main questions that need an answer in order to be able to engineer and develop more effective learning products are: How technology can yield an added value in course management? What can be done with technology that could not be done without it? To answer these questions, the educational software production needs to be focused on the process of learning and on the enrichment of the educational processes. Specific surveys need to be developed to monitor these aspects. This paper presents a new survey engineered to monitor the effective usefulness for the learning process of university learning objects.

Manuscript received March 18, 2007.
Revised manuscript received July 14, 2007.

This work was supported by the Italian Minister for University and Research (MIUR), and by the University of Bari.

Prof. Sebastiano Impedovo is with the "Centro Rete Puglia" - via G. Petroni, 15/F.1, Bari, Italy - and the Department of Computer Science - via Orabona, 4, Bari, Italy - of the University of Bari - Piazza Umberto I, n. 1 70100 Bari, Italy. (phone: +39 080 5575931; fax: +39 080 5575938; e-mail: impedovo@retepuglia.uniba.it)

II. Good Engineering Principles for e-Learning Products

At least five principles need to be considered while developing learning products [1]:

a) Content based on fundamental ideas;
b) Incorporation of different cognitive levels;
c) High degree of interaction;
d) Feedback;
e) Visualization and fit for use.

a) The production of multimedia learning software need to be centered on fundamental concepts. Bruner's concept of "fundamental idea" [2], better qualified by Schwill [3] as a schema for thinking, acting describing or explaining, that is applicable in different areas, that may be demonstrated and taught on every intellectual level, that can be clearly observed in the historical development and will be relevant in the longer term, and that are related to everyday language and thinking, need to be considered.

b) Educational software offers a broad range of task at different cognitive levels. Bloom [4] developed the taxonomy with six cognitive levels, arranged in an increasing complexity order:

- Knowledge;
- Comprehension;
- Application;
- Analysis;
- Synthesis;
- Evaluation.

Good educational software would emphasize the higher cognitive levels: analysis, synthesis and evaluation.

c) A high degree of interaction defined by Laurel [5] as involvement in the computer representations of the contents would characterize educational software. Schulmeister [6] suggests six increasing human-computer level of interaction:
   - No interaction at all, but only display of information;
   - Navigation through the representation of information;
   - Multiple representation of the content;
   - Possibility of modifying the parameters of the representation;
   - Possibility of modifying the content;
   - Possibility of creating and manipulating objects and observe system reaction.

   Berg [7] observes that highly interactive software is almost not existent in higher education.

d) The software feedback can assist the learning process. Roughly there could be defined two levels of feedback: implicit feedback and explicit feedback. In implicit feedback the learner must interpret the output the software produces while he interacts with it. In explicit feedback an automated system suggests comments and right choices, points to learner mistakes and correct answers, and provides support and explanations.

e) When people interact with a software product, they need to familiarize with the software interface, but since in learning products the software interface is not the subject itself, it should be as self explanatory as possible. There are several guidelines to design multimedia objects [8] and to use web contents [9], but in practice, in many cases, such guidelines are not effectively applied and they are reduced to the excessive use of animations. Guzdial and Soloway [10] argued that educational software needs to correspond to multimedia environments and to student everyday use of computer. Moreover according to Varisco [11], [12] a meaningful learning need to be:
   - Constructive: learning is a process that starts with information/knowledge already available to the learner;
   - Active: the learner actively participates to the learning process;
   - Intentional: the goals to reach are understood and accepted from the learner;
   - Collaborative: the new knowledge is built within relational contests;
   - Conversational: the learning process is carried on in a dialogic form;
   - Contextual: the learning task corresponds to significant tasks of the real world;
   - Thoughtful: the learners organize what they learn reflecting on performed actions and on taken decisions.

   The final objective of a learning object is to realize three fundamental learning goals:
   - To form learners responsible of their learning, capable to manage processes to reach aims and to understand their learning needing;
   - To promote real and meaningful learning environments and contexts, enabling students to retrieve information and build knowledge by using different learning ways;
   - To create stimulating situations and learning dynamics that prelude to wider learning tasks.

   Finally, according to McTighe and Wiggins [13], the purpose of questions in tests is to:
   - Start and motivate the learning process;
   - Drive learning attention;
   - Steer learners giving them hints for researches and reflections;
   - Point out the main ideas and the most important concepts.

III. USABILITY PROBLEMS IN E-LEARNING

In spite of all efforts, in the last years e-learning has experienced slow user growth involvement and high dropout rates in many organizations: users become easily frustrated or unenthusiastic about the material and do not complete learning activities [14]. Available usability tests do not provide designers with suggestions to design courses that capture users' interest.

Classical usability tests are already part of software and product design. Nielsen [9] brought the concept of usability into the web, making web pages simple to navigate and intuitively organized. In e-learning these principles need to be specialized to encompass a few more concepts. A learning web page is usable if it is effectively useful. A learning product must not only have an easy to use interface, but it should also serve a purpose. Learnability of the learning product should also be considered. Norman [15] defined Learnability as the ease and the seed with which users can figure out how to use a product without training or manuals. In the world of e-learning this definition need to be better qualified to include the ability of learners to effectively learn and retain skills and knowledge. The level of learnability of a course is undeniably associated with the strengths and weakness of the instructional design. The e-learning products, engineered with usefulness and learnability in mind, have intrinsic high instructional value [16]. The products will result more supportive to learners' activities and students will be more motivated in the use. Elements missing in e-learning, such as instructor presence and actual physical meeting

environments can be easily encompassed with learner involvement. Involvement of learners in the use of learning product is the factor that can spread out e-learning.

E-learning specific usability testing activities need to be carried on to allow better understanding of learners' needing and to create a learning culture made up of intrinsically motivated users.

Achieving usability into the design of e-learning products includes:

- Utilizing knowledge gained during the production phases;
- Employing interface design principles;
- Using instructional design principles.

These principles would not be considered in isolation but viewed through the lens of:

- Feedback;
- Curiosity;
- Relevance;
- Control;
- Challenge;
- Contextualization.

By considering for instance feedback, visual and audio cues in interface design help users to understand the consequences of their actions; guidance and remediation in the instructional design offer a chance to reinforce learning concepts.

By leveraging, for instance, curiosity, learning product developers can ensure a course design that creates an environment of discovery providing a continuously challenging activity always above the users' current level of competency.

Using instructional design and user interface principles together to the motivational goals allow promoting an integrated design process that better meets the needs of the learners.

Usability evaluation need also to include post-course assessments, surveys and interviews, to gain a deeper understanding of the impact the training product has on the learners. The combination of all these elements helps measure whether or not the e-learning program meets the prefixed goals. Such activities enable also continuous administration of courses by successive refining: as further new needs are discovered and new learner populations are hired, the cycle of usability enhancement can continue and help develop engaging courses that result more usable, useful, learnable and motivating.

IV. Learnability of e-learning products

Learnability can be defined as the capacity of an e-learning system to support or activate a specific cognitive process [17].

One of the most important aspects to consider while building didactic materials is the management of the mnemonic capability. The modal model [18] is the most widespread model to describe the way in which brain operates. It describes different types of memory with various functions. According this model, an external stimulus (text, sound, image) hits sensorial registers (sight, hearing, touch, etc.), enters in the sensorial storage and is compared with already known stimuli, then it is classified and passes into the working memory. The working memory interacts with the long term memory where information are stored and kept alive to constitute the personal knowledge background.

To make learnable a didactic object means to allow learners to use their own memorization capabilities for didactic aspects, while lightening their mnemonic charge from accidents such as interface structures or operational functionalities. It means to promote the birth and the growth of stimuli that allow an easy recovering of already acquired notions.

The expectancy grammar represents the store of knowledge that everybody develops with experience and study. According to Oller [19] it represents the real psychologically interiorized grammar. People speaking or writing plan what to say or write in the next future and control the result, to see if it corresponds with the desired or expected results.

If the speaker intention corresponds with the hearer assumptions, communication is efficient and effective, otherwise it fails. The same principles can be applied in e-learning [20]: learners, beside expectation based on their historic-cultural background, develop new expectations during learning. Increasing learnability means to promote the identification of expectations and to facilitate matching operations between past knowledge and new information: it means to enhance learners' baggage with new elements, structures and contents and to anticipate their expectations.

V. Overview of existing surveys

In past years some surveys have been proposed to evaluate usability of e-learning product. In many cases, they consider some aspects in spite of others. The most important are:

- COLLES;
- CLES;
- ATTLS.

A. COLLES – Constructivist On-Line Learning Environment Survey

It has been designed to monitor the extent of the interactive capacity of e-learning products to engage students in dynamic learning practices and to show how web teaching enriches distance students' ways of knowing; it generates a measure of students' perception of both their preferred and actual on-line classroom environments. The COLLES contains 24 statements grouped in 6 scales [21], each of which address a key question about the quality of the on-line learning:

- Relevance: How relevant is on-line learning to students' professional practices?
- Reflection: Does on-line learning stimulate students' critical reflective thinking?
- Interactivity: To what extent do students engage in on-line rich educative dialogue?
- Tutor Support: How well do tutor enable students to participate in on-line learning?

- Peer Support: Is sensitive and encouraging the support provided by fellow students?
- Interpretation: Do students and tutors make good sense of each other's communications?

There are three forms of the COLLES: a preferred form, an actual form and a combined preferred and actual form. It contains a five-point Likert-type response scale, with scores ranging from 1 to 5. The survey is based on social constructivism that considers the learner as an active conceptual actor within a socially interactive leaning environment. Social constructivism is considered as a strategy for knowing the way in which the learner collaborate reflectively to co-construct new understandings, especially in the context of mutual inquiry grounded in their personal experience.

The development of students' communicative competence, that is to say the ability to engage in open and critical discourse with both teacher and peer is essential in this model. The discussion need to be oriented to constructing reciprocal understanding and a critical attitude towards underlying assumptions.

B. CLES – Constructivist Learning Environment Survey

Developed by Peter C. Taylor and Barry J. Fraser at Curtin University of Technology, the CLES survey [22] was intended specifically for science classrooms, and includes five sections:

- "Learning about the world",
- "Learning about science",
- "Learning to speak out",
- "Learning to learn"
- "Learning to communicate".

The survey is available in two versions, actual and preferred. Each version consists of 25 questions with 5 possible answers each one: "almost never", "seldom", "sometimes", "often", "almost always".

C. ATTLS – Attitudes Towards Thinking and Learning Survey

The theory of 'way of knowing' originally from the field of gender research [23] provides a survey tool to examine the quality of discourse within a collaborative environment. The ATTLS [24] is an instrument to measure the extent to which a person is a 'Connected Knower' or a 'Separate Knower'. A Connected Knower tends to find learning more enjoyable, congenial and more willing, and tends to build on ideas of others. A Separate Knower tends to take a more critical and argumentative stance to learning.

VI. THE NEW PROPOSED SURVEY

The quality of educational software is evidently the product of many factors; therefore, there are different quality aspects to consider for obtaining good results. In this paper only a selected number of quality criteria with high level of abstraction, investigating the most relevant aspects of the e-learning process, are considered.

The proposed survey consists of three main sections:

- The first section considers *quality in use*;
- The second section considers *learnability*;
- The third section collects information about *involvement capability*.

The *first section*, about quality in use, considers various factors (Table 1):

- The *simplicity of the graphic style:* to verify if the use of the interface makes easy learning, the number of colors, the presence of carelessness, the character readability and the style coherence are investigated;

TABLE I
QUALITY IN USE FACTORS

Simplicity of the graphic style	
	laying
	colours
	distracter absence
	characters
	graphics
	multimedia
Distinction of interface elements	
	distinction
	friendliness
	working
Operation of navigation tools	
	sequence
	operation
Availability of multimedia elements	
	number
	loveliness
	sufficiency
	running
Coherence of page contents	
	text
	multimedia
Accuracy of multimedia production	
	audio
	video
	text
	graphics
	images
	animations
Overall easiness in use	
	usability
	organization
	explanation
	visualization
	interaction

- The *distinction of interface elements:* to verify their distinguishable characteristics, the difference in representation of buttons, links, media bars, navigation tools, and other objects is investigated;
- The *operation of navigation tools:* to verify their presence, efficiency and kind of allowed navigation facilities is investigated;
- The *availability of multimedia elements:* to verify the recognition and operation of included audio, video, animations, etc;
- The *coherence of page contents:* to verify the coherence between information in the presentation page and the one included in the associated multimedia elements;
- The *accuracy of multimedia production:* to verify the quality of multimedia elements in the various pages;
- The *overall easiness in use* of the didactic module:

to verify the level of satisfaction of end users, the organization level of the course and the consistency of presentation pages are investigated.

The *second section*, dealing with content learnability (Table 2), investigates:

TABLE II
LEARNABILITY FACTORS

Clarity of the didactic objectives	
	presentation
	achievability
	subject difficulty
Clearness and correctness of the content	
	clearness
	syntax - error absence
	semantics - error absence
Congruity of lexicon	
	lexicon
	periods
	understanding
	explanation
Adequacy of contents	
	novelty
	enrichment
	accessibility
	comprehensibility
Applicability to real situations	
	definitions
	theorems
	examples
	simulations
	demonstration
Coherence, consequence and clarity of explanations	
	coherence
	consequence
	clarity
	motivation
	detail
Presence and easy identification of evaluation instruments	
	identification
	use
	clarity of questions
	usefulness
	completeness
Stimulus to return back to visited contents	
	during learning
	during tests
Measurement of comprehension	
	availability
	understanding
	detail
Individualization of not well understood concepts	
	individualization
	internal resources
	external linked resources
	more researches

- *The clarity of the didactic objectives:* to verify if the subject matter has been clearly individuated, the kind of the subject and the specific argument of the learning module are investigated, the level of difficulty and the declared degree of comprehension of the topic are also inspected;
- *The clearness and correctness of the content:* to verify the quality of the didactic material, the syntactic and semantic correctness and the absence of ambiguities in content pages are investigated;
- *The congruity of lexicon:* to verify if words and formal expressions are adequate to the presented subject, the use of terms not easily, or not immediately comprehendible is verified, to see if new words are explained and commented before their use;
- *The adequacy of contents:* to verify if contents add new information to the learner knowledge, it is investigated if matter complexity is made simple by explanation, if explanation is comprehensible and if presentation drives the learner toward reflection and close investigation and inspection;
- *The applicability to real situations:* to verify if the subject is a model of real situations, it is investigated if concepts are expressed with formal demonstration, or practical examples, or both, and if exemplifications and detail level are adequate to the learner;
- *The coherence, consequence and clarity of explanations:* to verify the level of organization of the presentation, it is investigated if the learner necessitates of returns to already visited pages;
- *The presence and easy identification of evaluation instruments:* to verify their identification level and their validity, it is verified if questions and answers are expressed with clarity and without ambiguity, and if they are immediately comprehensible;
- *The stimulus to return back to visited contents:* to verify learners needing to complete their preparation, it is investigated if learners need revisiting the didactic material and if questions are consistent with the various aspects of the subject;
- *The expression of a comprehension level:* to verify if learners find a measure of their level of comprehension, the presence and the type of the measure is investigated;
- *The individualization of not well understood concepts:* to verify if it is possible to determine which concepts need further in-depth study, concepts not clearly understood and associated didactic materials are individualized and pointed out.

The *third section* contains final questions to investigate the level of involvement of the learner in the didactic module (Table 3); it investigates if:

- The entire *didactic module spurs learners* on further researches;
- The *availability and use of reference material* result useful;
- The *quantuity of material* included in the didactic module ids sufficient or if it results better to use external products;
- The entire set of resources and documents allows a *satisfactory comprehension of topic.*

TABLE III
INVOLVEMENT FACTORS

Spurs to further researches	
	more details
	more concepts
Usefulness of teaching material	
	advantages
	integration with other forms
	availability of information
Sufficiency of materials	
	length
	adaptation to new media
Satisfactory comprehension of the topic	
	gain
	satisfaction

At the end, in the last question of the survey, the learner is invited to indicate if there is something missing in the learning product, and where to include the eventual missing arguments in the presentation of the electronic lesson.

VII. First Survey Results

First results have been obtained by utilizing the learning module on Introduction to Discrete Systems (Figure 1).

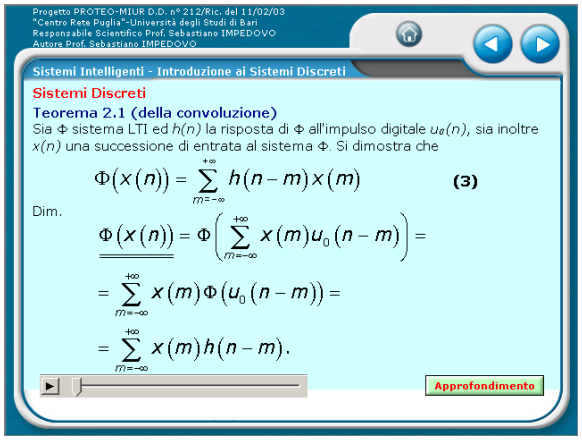


Fig. 1 Convolution Theorem: lesson page

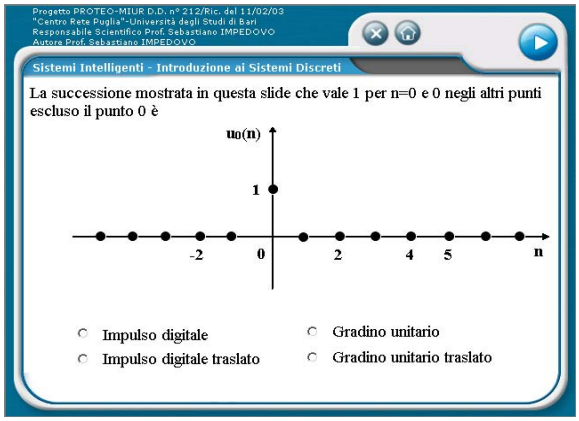


Fig. 2 Digital pulse: test page

The learning module was developed, published and imported in the Oracle iLearning LMS during the activities of the PROTEO project carried on at the University of Bari with the support of the Italian Government and of the European Union [25], [26], [27]. It constitutes an enhancement of former activities and a starting point for further developments [28], [29], [30]. Each section of the didactic module consists of a lesson learning object and of a test learning object (Figure 2).

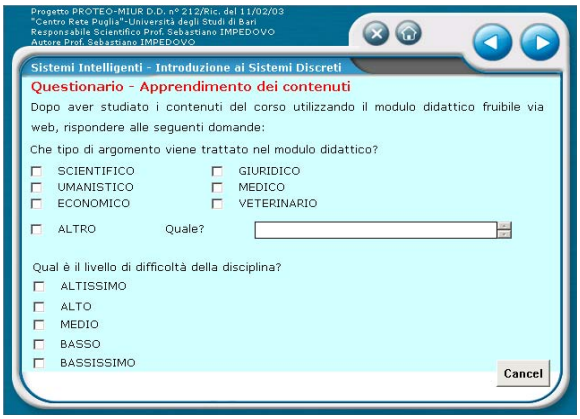
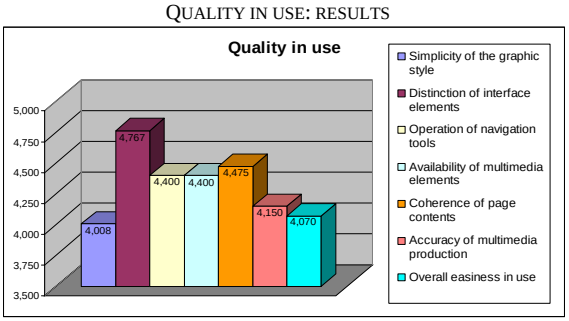


Fig. 3 Learnability section: 1st survey page

By considering the didactic module under examination, a fist evaluation session involved 20 university students that used the product in e-learning. They used the new survey (Figure 3).

Analyzing the results of the section on quality in use it results that the graphic laying and the choice of colors are good and that there is no distraction element; the characters have a discrete readability and there is an enough good coherence in page presentation. The elements of pages result easily distinguishable and the correctly operating navigation tools enable a sequential navigation among pages. Multimedia elements are included in almost all pages and they result correctly operating. Information in pages and associated multimedia elements results coherent, but not always audio files are of good quality (Table 4).

TABLE IV
QUALITY IN USE: RESULTS



On the whole, the didactic module results to have a good usability level, with a good organization. The written parts in the presentation pages and the comments result to have a more than discrete quality and graphics and images are more than

good; animations and audios are between discrete and good.

By considering the learnability of the didactic module it results that all students classify the subject as a scientific topic with an enough high level of difficulty. Not all learners consider clearly expressed the objectives of the learning product, but all of them agree to say that the final goal of the product is to introduce to discrete systems, and consider that the attainment level of the objectives is more than discrete. The explanation results syntactically and semantically correct, without mistakes or ambiguities; the lexicon is completely faithful to the subject, and new terms are always explained before their use (Figure 4).

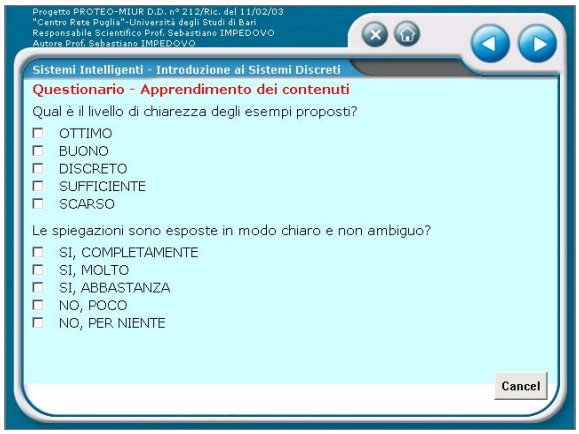
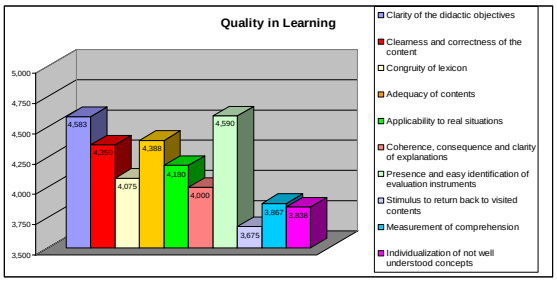


Fig. 4 Presentation and example: clarity page

The contents add new knowledge to learners and subject complexity is made enough simple; the comprehension level is discrete and the presentation forces learners to reflect a lot. The concepts are explained by mean of examples, definitions, theorems and demonstrations. Situations are applicable to real situations and are explained with enough good examples (Table 5).

TABLE V
LEARNABILIY: RESULTS

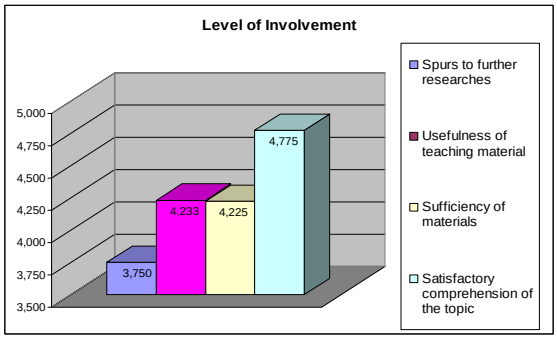


The explanation technique is coherent in the entire product, but in some cases the learner needs to return on already visited pages to reconsider former understanding.

Evaluation tests result available and easily selectable. The questions, with relative answers, are clear and not ambiguous also if they require some time to be understood. In some cases the tests forces learners to return to the didactic material to deepen the presented concepts. The tests cover all the principal topics of the learning module and they offer a measure of the subject comprehension. The level of understanding achieved by learners is expressed as the sum of available points associated to each question and as the percentage of correctness of the answered questions. If feedback is available, it is easily possible to verify the correctness of answers; otherwise, it is necessary to reflect on the values of answers by reconsidering the didactic pages.

By considering questions in the third section, in some cases learners tries further researchers and considers useful the availability of reference materials. The entire set of available resources and documents allow an enough good comprehension of the subject (Table 6).

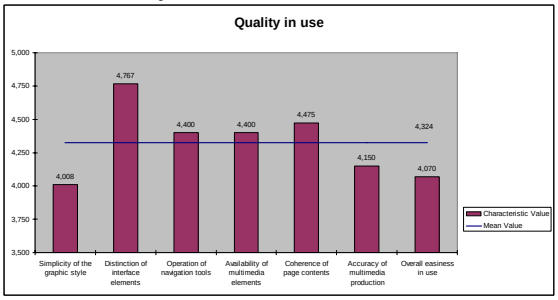
TABLE VI
INVOLVEMENT: RESULTS



VIII. CONCLUSION

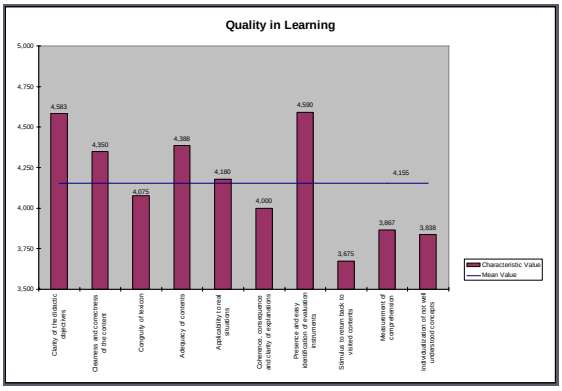
By mean of the proposed survey, the usefulness of a learning object can effectively be investigated in its various aspects, as the effectiveness, efficiency and satisfaction with which users can achieve tasks in a particular learning environment.

TABLE VII
QUALITY IN USE: MEAN VALUE



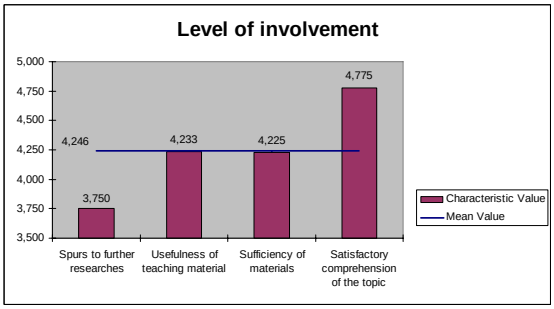
The survey shows that the product illustrates the content in a way that is easy to learn and remember, visually pleasing and fun to use, quick to recover and efficient in use. Usability issue includes not only interface and navigation design aspects (Table 7), but also content organization, accessibility and memorization properties. Learnability effectively refers to the qualities of the product that help making learning easy and fruitful (Table 8).

TABLE VIII
LEARNABILITY: MEAN VALUE



The survey allows evaluating not only the quality in use of a learning module but also its usefulness, concept explanation, content learnability and learner involvement (Table 9).

TABLE IX
INVOLVEMENT: MEAN VALUE



It enables to monitor the quality of the interface, the quality of contents and the capability to provide new knowledge and cognitions. The main properties of the learning product are all investigated and sound out by considering different aspects.

Critical factors are individualized and highlighted.

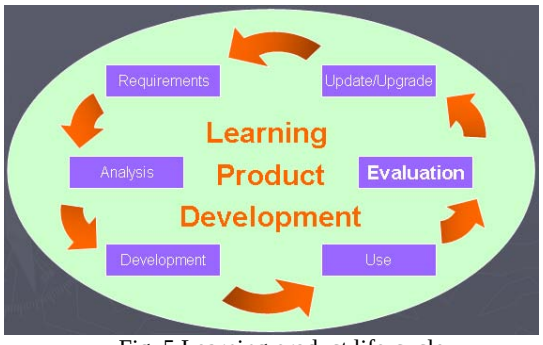


Fig. 5 Learning product life-cycle

The results point out not only the quality of the multimedia product to provide learning, but also the real needing of learners and possible enhancements to the actual implementation of the virtual lessons during the evaluation phase within the lifecycle of learning products (Figure 5).

E-learning products created with ease-of-use, usefulness, learnability and motivation in mind effectively result simple, have high instructional value and are supportive to the learners' activity.

REFERENCES

[1] R. Reichert, W. Hartmann, On the Learning in e-Learning, Proceedings of EDMEDIA 2004 – World Conference on Education, Multimedia, Hypermedia and Telecommunications, pp. 1590-1595, June 23-26, 2004, Lugano, Switzerland.

[2] J. S. Bruner, The Process of Education, Harvard University press, 1960.

[3] A. Schwill, Fundamental Ideas of Computer Science, EATCS-Bullettin 53, pp. 274-295, 1994.

[4] B. Bloom, Taxonomy of Educational Objectives, Longmans, London, 1956.

[5] B. Laurel, Computers as Theatre (second edition), Addison-Wesley publishing, 1993.

[6] R. Schulmeister, Taxonomy of Multimedia Component Interactivity - A Contribution to the Current Metadata Debate, Studies in Communication Sciences, 3(1), pp. 61-80, 2003.

[7] G. A. Berg, The Big Questions, International Journal on e-Learning, 1(2), pp. 5-6, 2002.

[8] R. Mayer, Multimedia Learning, Cambridge University press, 2001.

[9] J. Nielsen, Designing Web Usability, New Riders Press, pp. 432, 1999.

[10] M. Guzdial, E. Soloway, Teaching the Nintendo Generation Program, Communications of the ACM, 45(4), 17-21, 2002.

[11] B.M. Varisco, Le Teorie e le Pratiche Didattiche, L. Galliani, F. Luchi, B.M. Varisco editors, in La Comunicazione Multimediale, Tecnoproject,1998.

[12] B. M. Varisco, Paradigmi Psicologici e Pratiche Didattiche per il Computer, V. Minoro, G. Olimpo, D. Persico editors, in Tecnologie Didattiche, Metodi e Strumenti Innovativi per l'Apprendimento, edizioni Menabò, 1996.

[13] J. McTighe, G. Wiggins, Fare Progettazione, LAS, Roma, 2004.

[14] M. Notess, Usability, User Experience, and Learner Experience, ACM eLearn Magazine, August 2001.

[15] D. A. Norman, The Design of Everyday Things, Doubleday, New York, 1989.

[16] S. Shilwant and A. Haggarty, Usability Testing for E-Learning, Issue of Chief Learning Officer magazine, August 2005.

[17] F. Anzalone, F. Caburlotto, E-learning - Comunicare e Formarsi Online, Lupetti, Milano, 2003.

[18] R. C. Atkinson, R. M. Shiffrin, Human Memory : A Proposed System and its Control Process, K. V. Spence and J. I. Spence editors, in Psychological of Learning and Motivation: Advances in Research and Theory, Academic press, New York, vol. 2, pp. 89-105, 1968.

[19] J. W. Oller, Issues in Language Testing Research, Newbury House Publishers, Rowley, 1983.

[20] F. Caburlotto, Apprendibilità: l'Usabilità nell'Apprendimento, Quaderni di Webbit: e-Learning, Padova, Edizioni Webbit, 2004.

[21] P. Taylor, D. Maor, Assessing the Efficacy of Online Teaching with the Constructivist On-Line Learning Environment Survey, A. Herrmann and M.M. Kulski Eds, in Flexible Futures in Tertiary Teaching, Proceedings of the 9th Annual Teaching Learning Forum, 2-4 February, 2000, Perth, Curtin University of Technology.

[22] P. C. Taylor, B. J. Fraser, L. R. White, CLES: An Instrument for Monitoring the Development of Constructivist Learning Environments, National Key Centre for School Science and Mathematics, Curtin University, Australia, paper presented at the annual meeting of the American Educational Research Association, New Orleans, April 1994.

[23] M. F. Belenky, B. M. Clinchy, N. R. Golderberg, J. M. Tarule, Women's Ways of Knowing: The Development of Self, Voice and Mind, New York, Basic Books Inc, 1986.

[24] K. M. Galotti, B. M. Clinchy, K. Ainsworth, B. Lavin, A. F. Mansfield, A New Way of Assessing Ways of Knowing: the Attitudes Towards Thinking and Learning Survey (ATTLS) Sex Roles, 40 (9/10), 1999, pp. 745-766.

[25] S. Impedovo, G. Dimauro, R. Modugno, G. Pirlo, " The e-Learning Project at the University of Bari", WSEAS Transactions On Advances In Engineering Education, Issue 2, Volume 3, ISSN: 1790-1979, February 2006, WSEAS press, pp. 75-79.

[26] G. Dimauro, D. Impedovo, R. Modugno, "A LMS to Support e-Learning Activities in the University Environment", WSEAS Transactions on Advances in Engineering Education, Issue 5, Volume 3, ISSN: 1790-1979, May 2006, WSEAS press, pp. 367-374.
[27] S. Impedovo, G. Dimauro, A. Ferrante, N. Greco, M. G. Lucchese, R. Modugno, G. Pirlo, L. Sarcinella, "The PROTEO Project: New Advances in e-Learning Activities at the University of Bari", WSEAS Transactions on Communications, Issue 1, Volume 5, January 2006, ISSN 1109-2742, WSEAS press, pp. 23-30.
[28] S. Impedovo, R. Modugno, G. Pirlo, "Evaluation of e-Learning Activities: A Participant-Based Approach", WSEAS Transactions on Advances in Engineering Education, Issue 5, Volume 3, ISSN: 1790-1979, May 2006, WSEAS press, pp. 348-353.
[29] S. Impedovo, G. Dimauro, G. Pirlo, "On the Evaluation of e-Learning Activities", WSEAS Transactions on Advances in Engineering Education, Issue 2, Volume 3, February 2006, ISSN: 1790-1979, WSEAS press, pp. 86-91.
[30] S. Impedovo, "The Rete Puglia Centre: An Apulia Region Infrastructure for the e-Learning", WSEAS transactions on Advances in Engineering Education, Issue 6, Volume 3, ISSN: 1790-1979, June 2006, WSEAS press, pp. 593-600.

Prof. Sebastiano Impedovo was born in Putignano (Bari-Italy) on May 17, 1947. He obtained his degree in Physics with honours at the University of Bari in 1972. He became Assistant Professor in Electronics, then Associate Professor in Cybernetics in 1981, and in 1987 he became Full Professor in Operating Systems at the University of Bari.

He is an IAPR Fellow and a member of IAPR, ACM, IEEE, IGS, ANIPLA and AICA. He has published more than three hundred papers and seven books in the field of handwriting recognition and intelligent systems for document analysis. He is a member of the editorial board of the International Journal of Pattern Recognition and Artificial Intelligence, and of the International Journal of Document Analysis and Recognition.

Sebastiano Impedovo organized several international conferences, workshops, schools and international panels on Image Analysis and Document Processing, Tele-teaching and Tele-working.

Sebastiano Impedovo was also the Director of the Department of Computer Science of the Bari University, the President of the Degree Course in Computer Science and a Member of the "Senate" of the Bari University; he was the Coordinator the PhD Course in Computer Science, the Director of the Bari Unit of the National Inter-University Consortium in Computer Science, a Member of the Scientific Board of the “Tecnopolis” Consortium and the Chairman of the Council of Department Directors of the University of Bari. Now he is the President of the Inter-Faculty Centre “Rete Puglia” of the University of Bari.