# Quality enhancement in e-learning activities: improvements by mean of a newly engineered e-learning survey

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*Abstract:* - This paper deals with quality enhancement of e-learning activities through the satisfaction analysis expressed by university learners while using specific learning modules. The paper considers a newly engineered survey that evaluates not only quality in use but also quality in learning and learner involvement. The quality of the interface, the friendliness of the contents, the accessibility of concepts and the capability to provide new knowledge and skills are all considered. Through the paper, the various aspects concerning the different discriminating factors that characterize e-learning processes are investigated. The results, obtained during university teaching activities, show the usefulness of the survey in individualizing the more improvable factors by understanding effective learners' needing.

*Key-Words:* e-learning, learnability, quality evaluation, survey, usability.

## 1 Introduction

Information and Communication Technology (ICT) offers people new, free of time and space constraint, facilities for continuous and lifelong learning. The e-learning offers people the possibility to become skilful and acquire knowledge practically without any limitation.

So far, in the development and management of e-learning activities emphasis has been generally devoted to technical aspects, whereas the relevance of the learning products for the actual process of learning has not been enough considered. Indeed the most important aspect of a learning product is its capability to provide knowledge and skill by stimulating an in dept study, further researches and close investigations. The added value of an e-learning product is in its aptitude to provide learning and not in the instrument used to vehicle it.

The freedom of new learners need to be transformed in additional time to be spent in approaching new facilities and in practicing with new exciting knowledge activities and new learning experiences. Indeed, the educational software production needs to be focused on the process of learning and on the enrichment of the educational processes.

This paper presents a specific study conducted to investigate the way in which a survey can be used not only to monitor learner satisfaction while performing specific e-learning activities, but also on how to use the obtained results to enhance the quality of the learning process by selecting the more suitable factors: the ones that can also provide greater enhancements to learner satisfaction.

The paper is organized as follows: Section 2 summarizes the main engineering principles and the most widespread guidelines to develop learning products; in Section 3 the usability problems in educational e-learning software are discussed; Section 4 deals with the design of e-learning products; Section 5 briefly presents the newly engineered survey to evaluate quality of e-learning university courses; in Section 6 the experimental results are presented and discussed.

## 2 Good Engineering Principles

Learning is a very special task that cannot be approached as a conventional kind of work, with only a number of problems to be solved and various outputs to be produced [1].

So far, learning has been defined in terms of behavior [2], knowledge [3], knowledge and observable behavior [4]. Whatever definition is adopted, learning is always considered as a positive change over time that aims at improving capabilities to cognition, through a series of actions through personal observation and interaction. Therefore, learning is not a simple process of transmitting

information from someone who knows to someone who does not. Instead learning is an active process that happens through direct experience, conducted by people engaged in authentic tasks [5].

At least five principles need to be considered while developing learning products [6]:

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" [7], better qualified by Schwill [8] as a schema for thinking, acting describing or explaining, need to be considered.
b) Educational software offers a broad range of tasks at different cognitive levels. Bloom [9] developed the taxonomy with six cognitive levels, arranged in an increasing complexity order. Good educational software would emphasize the higher cognitive levels: analysis, synthesis and evaluation.
c) A high degree of interaction defined by Laurel [10] as involvement in the computer representations of the contents would characterize educational software. Schulmeister [11] suggests six increasing human-computer level of interaction. Berg [12] observes that indeed highly interactive software is almost not existent in higher education.
d) The software feedback can assist the learning process. Roughly two levels of feedback could be defined: implicit feedback and explicit feedback.
e) There are several guidelines to design multimedia objects [13] and to use web contents [14]. Guzdial and Soloway [15] argued that educational software needs to correspond to multimedia environments and to student everyday use of computer. Moreover Varisco [16, 17] individualize factors that make meaningful the learning process. Finally, McTighe and Wiggins [18], focus the purpose of questions in tests.

## 3 Usability problems in educational e-learning software

The ultimate objective for educational software is to be educationally beneficial. So it is important to understand how usability can contribute to educational goals [19]. Squires and Preece [20] argue that software developers do not consider enough the implications of usability features of an educational package in order to achieve educational goals. So, in spite of all efforts, users become easily frustrated or unenthusiastic about the material and do not complete learning activities [21].

While, considering the design of web-based learning courses the active process that happens through direct experience takes the form of web navigation. Good design of a courses interface and good organization of contents is critically important. With software interfaces users return many times in the same environment and gradually learn to use the interface. While using the web-based learning interfaces, users must make sense quickly since the user is unlikely to use the environment for an extended period of time.

An instructional interface is effective when the learner is able to focus on learning contents and concepts rather than on how to access the learning content. The need to concentrate on the users' objectives rather than the tasks is of fundamental importance.

While making an attempt in identifying usability attributes, the first step is to define the context of use of web-based learning applications. Usability testing needs additional consideration under the light of web-based learning environments. Dringus [22] proposes of applying opportunely arranged software usability heuristics to evaluate web-based course environments.

Indeed, 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. Norman [23] 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 [24].

On the base of these assumptions, Squires and Preece [25] realized that the simple application of software heuristics is not sufficient because they fail to address the specific challenges of learner centred design and the issue of integration of usability and learning. The proposed set of learning with software heuristics contains the following guidelines:

- Match between designer and learner models;
- Navigational fidelity;
- Appropriate levels of learner control;

- Prevention of peripheral cognitive errors;
- Understandable and meaningful symbolic representations;
- Support of personally significant approaches to learning;
- Strategies for cognitive error recognition, diagnosis and recovery;
- Match with the curriculum.

Cronje [26] investigated to what extent some of the methods, used by educators, can be replicated over the Internet. He posed the question of how can adult learners respond to internet based role-play exercises and youthful metaphors. Dringus and Terrell [27] focus their interest on awareness, as a combination of visual and conceptual cues given to the learner that increases the immediate sense of presence of others in an online class. Moreover Forcheri [28] uses metaphors from working context while designing his prototype in order to engage workers to interact effectively with an on-line training application. Relevant to navigational fidelity is the work conducted by Parlangeli [29]. Piccoli [30] focus the work on examining the Virtual Learning Environments (VLE) effectiveness and learner control. Learning styles issue is a discriminating factor while supporting personally significant approaches to learning. Terrell and Dringus, [31] also investigated the effect of learning styles on student success in an on-line web-based learning environment.

All these researches point out that specific e-learning 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.

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.

Instructional principles common to diverse learning theories are the following [2]:

- Learners progress through stages or phases;
- Material should be organized and presented in small steps;
- Learners require practice, feedback and review;
- Social models facilitate learning and motivation;
- Motivation and contextual factors influence learning.

Usability evaluation needs to include post-course assessments, surveys, and interviews, to gain a deeper understanding of the impact that 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.

# 4 Designing e-learning products

The different learning theories and their major assumptions have guided design and development efforts. Chalmers [32] links learning theories as well as instructional theories in order to present potential improvements for research and development of computer-assisted instruction. Norman and Spohrer [33] combine learner-centred approach with constructivism and problem based learning. The ideas of active exploration and construction of meaning as well as the motivation to solve real problems in authentic contexts are here dominant. Norman and Spohrer [33] also focus their analysis on three dimensions of instruction: engagement, effectiveness and viability. The new paradigms place the learner in the centre of the learning process [34]. Cronje [26] relies on cooperative model and collaborativism while designing his virtual classroom. Pear and Crone-Todd [35] focus their study on a computer mediated teaching system developed by incorporating a social constructivism approach.

It is widely accepted that there is no ideal learning theory and/or model. According Leidner and Jarvenpaa [36], different learning approaches will be appropriate depending on the circumstances. Whichever model is selected an evaluation phase need to be considered.

# 5 The structure of the 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. The proposed survey consists of three main sections [37]:

- 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:

- The simplicity of the graphic style;
- The distinction of interface elements;
- The operation of navigation tools;
- The availability of multimedia elements;
- The coherence of page contents;
- The accuracy of multimedia production;

- The overall easiness in use of the didactic module.

The second section, dealing with content learnability, investigates:

- The clarity of the didactic objectives;
- The clearness and correctness of the content;
- The congruity of lexicon;
- The adequacy of contents;
- The applicability to real situations;
- The coherence, consequence and clarity of explanations;
- The presence and easy identification of evaluation instruments;
- The stimulus to return back to visited contents;
- The expression of a comprehension level;
- The individualization of not well understood concepts.

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

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

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.

# 6 Analysis of survey results

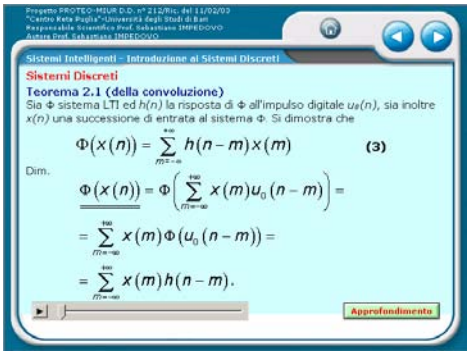



**Figure 1:** *Convolution Theorem: lesson page*

Analysis of survey results have been conducted by considering answers provided by university students which used the didactic module on Introduction to Discrete Systems (*Figure 1*), 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 [38, 39, 40].

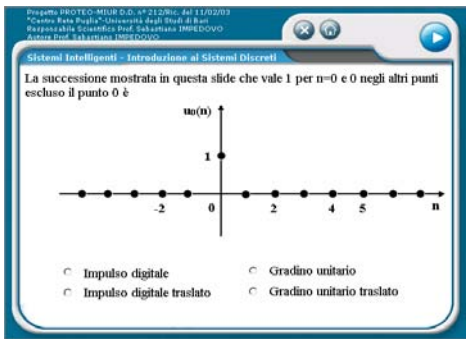



**Figure 2:** *Digital pulse: test page*

The results here presented represent an expansion and an enhancement of former activities [41, 42, 43]. Each section of the didactic module consists of a lesson and a test learning object (*Figure 2*).

The evaluation phase involved 20 university students which used the product in e-learning, and answered to the questions in the survey.

## 6.1 The quality in use

*Table* 1 summarizes the average occurrences in the three sections of the five possible scores.

Analyzing the results in the row corresponding to the section on quality in use the following observations can be made: on the average the 0,12% of the panel answered with a judgment corresponding to a 2, in the scale ranging from 1 (worst value) to 5 (best value), the 11,19% with a 3, the 44,83% with a 4, and the 43,86% with a 5, that is to say with the better judgment. The scores can be easily associated to the following judgments: insufficient, poor, sufficient, discrete, and good.

**Table 1:** *Score distribution in the three sections*

| | 1 | 2 | 3 | 4 | 5 | Color |
|---|---|---|---|---|---|---|
| Quality in use | 0% | 0,12% | 11,19% | 44,83% | 43,86% | |
| Quality in learning | 0% | 1,08% | 18,79% | 43,72% | 36,41% | |
| Level of involvement | 0% | 0,00% | 11,67% | 52,08% | 36,25% | |

*Figure 3* presents graphically the occurrence of the five scores in the different sections of the survey: The values corresponding to the quality in use are expressed in blue, the values corresponding to the quality in learning in brown, the values corresponding to the level of involvement in yellow.

As can bee seen, the poor judgments occur while considering quality in use and quality in learning, and, in these cases, they occur only with marginal

values. The sufficient judgments occur with a frequency a little above to 10,00% while considering quality in use and level of involvement, and with an occurrence near to 20,00% while considering quality in learning.

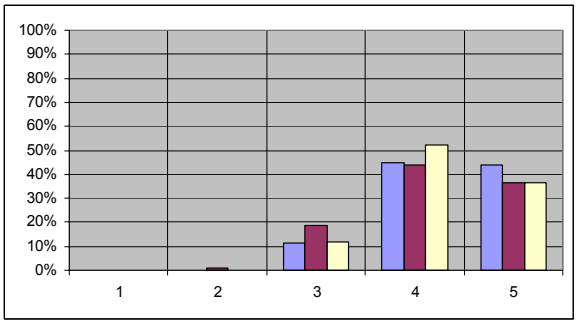



**Figure 3:** *Score occurrences the three sections*

More in detail *Table 2* presents the results obtained while taking into account the different factors considered in the section on quality in use.

By considering the simplicity of the graphic style on the average the 0,83% of the panel answered with a 2, the 22,50% answered with a 3, the 51,67% with a 4, and the 25,00% with a 5. By considering distinction of interface elements the 23,33% answered with a 4 and the 76,67% with a 5. By considering the operation of navigation tools and the availability of multimedia elements, the 7,50% with a 3, the 45,00% with a 4 and the 47,50% with a 5. By considering the coherence of page contents, the 2,50% with a 3, the 47,50% with a 4, and the 50,00% with a 5. By considering accuracy of multimedia production, the 18,33% answered with a 3, the 48,33% with a 4 and the 33,33% with a 5. By considering the overall easiness in use, the 20,00% with a 3, the 53,00% with a 4, and the 27,00% with a 5.

**Table 2:** *Score distributions in section one*

| | 1 | 2 | 3 | 4 | 5 | Color |
|---|---|---|---|---|---|---|
| Simplicity of the graphic style | 0% | 0,83% | 22,50% | 51,67% | 25,00% | |
| Distinction of interface elements | 0% | 0,00% | 0,00% | 23,33% | 76,67% | |
| Operation of navigation tools | 0% | 0,00% | 7,50% | 45,00% | 47,50% | |
| Availability of multimedia elements | 0% | 0,00% | 7,50% | 45,00% | 47,50% | |
| Coherence of page contents | 0% | 0,00% | 2,50% | 47,50% | 50,00% | |
| Accuracy of multimedia production | 0% | 0,00% | 18,33% | 48,33% | 33,33% | |
| Overall easiness in use | 0% | 0,00% | 20,00% | 53,00% | 27,00% | |

Analyzing the results of the previous table by columns (*Figure 4*), the score corresponding to 2 occurs only when considering the simplicity of the graphic style: the observed value is 0,83%, a marginal value. The 3 occurs with a frequency equal to: 22,50% when considering the simplicity of the graphic style; 7,50% when considering operation of navigation tools and availability of multimedia elements; 2,50% in coherence of page contents; 18,33% in accuracy of multimedia production; 20,00% in overall easiness of use.

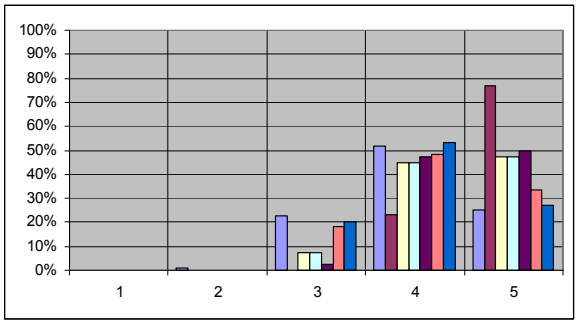



**Figure 4:** *Score occurrences in the first section*

To enhance the quality in use, by reducing sufficient judgments, the occurrence of the score corresponding to 3 needs to be reduced. The factors that can mainly contribute to quality enhancements are the ones with the greater occurrences in the column under consideration. So factors to firstly enhance in the learning module are the first and the last two of the third column. Moreover, the same factors exhibit the lower values while considering the score corresponding to 5. This means that learners effectively require more attention and specifications while considering these factors and engineer need to spend more time while considering these factors and developing related solutions.

## 6.2 The quality in learning

*Figure 5* summarizes the results obtained in the section on quality in learning.

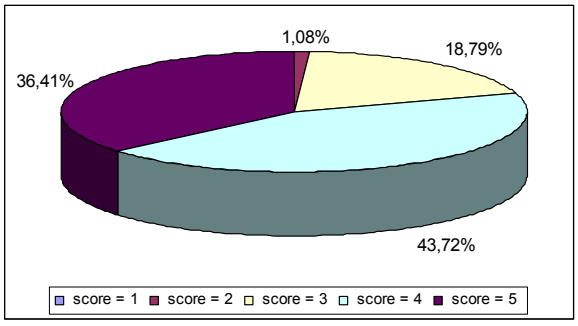



**Figure 5:** *Score occurrences in section two*

On the average the 1,08% of the test panel answered with a 2, the 18,79% answered with a 3, the 43,72% answered with a 4, and the 36,41% with a 5.

More in detail *Table 3* presents the average values obtained while considering the different factors in the section on quality in learning.

By considering the clarity of the didactic objectives the 41,67% answered with a 4, and the 58,33% with a 5. By considering the clearness and correctness of the content the 25,00% with a 3, the 15,00% with a 4, and the 60,00% with a 5. By considering congruity of lexicon the 22,50% answered with a 3, the 47,50% with a 4, and the 30,00% with a 5. By considering adequacy of contents, the 11,25% with a 3, the 38,75% with a 4 and the 50,00% with a 5.

**Table 3:** *Score distributions in section two*

| | 1 | 2 | 3 | 4 | 5 | Color |
|---|---|---|---|---|---|---|
| Clarity of the didactic objectives | 0% | 0,00% | 0,00% | 41,67% | 58,33% | |
| Clearness and correctness of the content | 0% | 0,00% | 25,00% | 15,00% | 60,00% | |
| Congruity of lexicon | 0% | 0,00% | 22,50% | 47,50% | 30,00% | |
| Adequacy of contents | 0% | 0,00% | 11,25% | 38,75% | 50,00% | |
| Applicability to real situations | 0% | 0,00% | 21,00% | 40,00% | 39,00% | |
| Coherence, consequence and clarity of explanations | 0% | 0,00% | 14,00% | 72,00% | 14,00% | |
| Presence and easy identification of evaluation | 0% | 0,00% | 0,00% | 41,00% | 59,00% | |
| Stimulus to return back to visited contents | 0% | 7,50% | 32,50% | 45,00% | 15,00% | |
| Measurement of comprehension | 0% | 3,33% | 21,67% | 60,00% | 15,00% | |
| Individualization of not well understood concepts | 0% | 1,00% | 40,00% | 36,25% | 23,75% | |

By considering applicability to real situations, the 21,00% with a 3, the 40,00% with a 4, and the 39,00% with a 5. By considering coherence, consequence and clarity of explanations, the 14,00% with a 3, the 72,00% with a 4, and the 14,00% with a 5. By considering presence and easy identification of evaluation instruments, the 41,00% with a 4, and the 59,00% with a 5. By considering the stimulus to return back to visited contents, the 7,50% with a 2, the 32,50% with a 3, the 45,00% with a 4, and the 15,00% with a 5. By considering the measurement of the comprehension level, the 3,33% with a 2, the 21,67% with a 3, the 60,00% with a 4, and the 15% with a 5. By considering the individualization of not well understood concepts the 40,00% with a 3, the 36,25% with a 4, and the 23,75% with a 5.

Looking at the results by columns (*Figure 6*), judgments below the sufficiency, corresponding to scores 2 or 1, occur only while considering stimulus to return back to visited contents, measurement of comprehension, and individualization of not well understood concepts. They are the only factors showing occurrences in the second column. More specifically the 7,50% of the test panel judged poor the stimulus to return to visited pages, the 3,3% believes that the measurement instruments are poor, and the 1,00% considered poor the individualization of not well understood concepts.

By considering the occurrences of sufficient judgments, corresponding to a score equal to 3, the greatest values of occurrences of this judgment can be found when considering: individualization of not well understood concepts (40,00%); stimulus to return back to visited contents (32,50%); clearness and correctness of the content (25,00%); congruity of the lexicon (22,50%); measurement of comprehension (21,67%); applicability to real situations (21,00%).

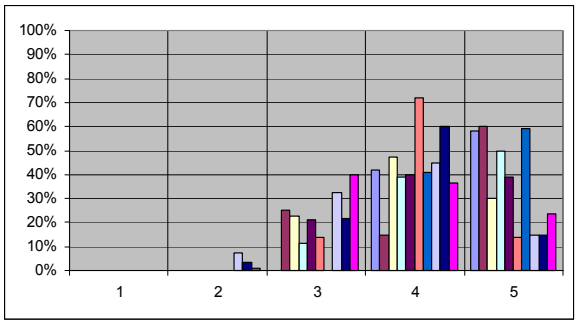



**Figure 6:** *Score occurrences in section two*

To enhance quality of the product by reducing occurrences of poor and sufficient judgments, the factors that show higher values of occurrences in the second and third columns should be firstly considered. In particular, by considering the last column, corresponding to the occurrences of the score 5, the lower occurrences of the best judgment can be observed while considering: stimulus to return back to visited contents (15,00%); measurement of comprehension (15,00%); individualization of not well understood concepts (23,75%); congruity of the lexicon (30,00%); applicability to real situations (39,00%).

The concomitance of the greater values in the second column, and of the lower values in the last (*Figure 6*) suggest that the individualized factors require greater attention. Marginal attention can also be paid to coherence, consequence and clarity of explanations because the low value of the occurrence in the last column (14,00%) is counterbalanced by the greatest value of occurrence in the last but one column (72,00%).

### 6.3 Analysis of the level of involvement

*Figure 7,* in the third and last section, presents results obtained while considering the level of involvement. Only scores corresponding to 3, 4 or 5 can be observed, with occurrences ranging from 11,67% to 52,08%. On the average, The 11,67% of the set of evaluators answered with a 3, the 52,08%

answered with a 4, and the 36,25% answered with a 5.

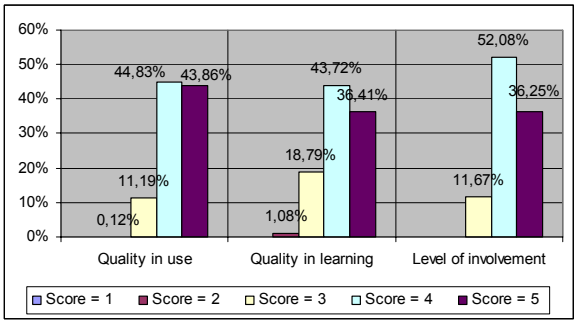



**Figure 7:** *Score distribution the three sections*

More in detail *Table 4* presents the results obtained while considering the different factors analyzed in the section on level of involvement.

By considering spurs to further researches, the 42,50% answered with a 3, the 40,00% with a 4, and the 17,50% with a 5. By considering usefulness of teaching material, the 1,67% with a 3, the 73,33% with a 4, and the 25,00% with a 5. By considering sufficiency of materials the 2,50% with a 3, the 72,50% with a 4 and the 25,00% with a 5. By considering the satisfactory comprehension of the topic the 22,50% answered with a 4 and the 77,50% with a 5.

**Table 4:** *Score distributions in section three*

| | 1 | 2 | 3 | 4 | 5 | Color |
|---|---|---|---|---|---|---|
| Spurs to further researches | 0% | 0,00% | 42,50% | 40,00% | 17,50% | |
| Usefulness of teaching material | 0% | 0,00% | 1,67% | 73,33% | 25,00% | |
| Sufficiency of materials | 0% | 0,00% | 2,50% | 72,50% | 25,00% | |
| Satisfactory comprehension of the topic | 0% | 0,00% | 0,00% | 22,50% | 77,50% | |

Analyzing the results collected in this last section by columns (*Figure 8*), the following observations can be made. Nobody expressed a judgment corresponding to a 1 or 2 in any case. No judgment corresponding to a 3 occurs when considering satisfactory comprehension of the topic. Marginal expressions of sufficiency can be observed when considering usefulness of teaching materials (1,67%) and sufficiency of materials (2,50%). Indeed, non marginal occurrence of sufficiency judgments can be observed when considering spurs to further researches (42,50%).

Looking at the last column in the figure, the occurrence of the best judgments about spurs to further researches exhibit the lower value, corresponding to 17,50%, immediately followed by usefulness of teaching material and sufficiency of materials (25,00%).

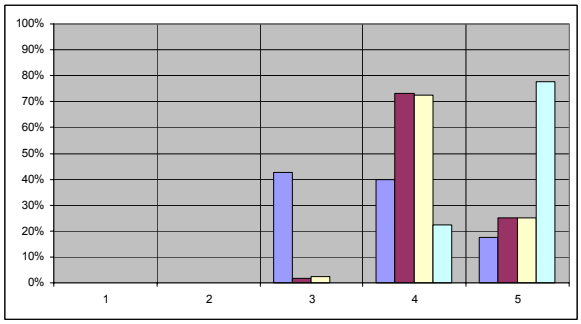



**Figure 8:** *Score occurrences in section three*

Undoubtedly the factor that can more significantly contribute to increase the level of involvement of learners is the enhancement of the activities that spurs to further researches that presents complementary values in the expression of 3 and 5 judgments.

## 6.4 Synthetic analysis of score occurrences

*Figure 9* reports the percent adoption of the five different judgments in the entire survey. The judgments corresponding to a 2 occurs in the 0,40% of cases, the judgments corresponding to a 3 in the 15,53% of cases, the 4 occurs in the 46,47% of cases, and the 5 occurs in the 37,60% of cases.

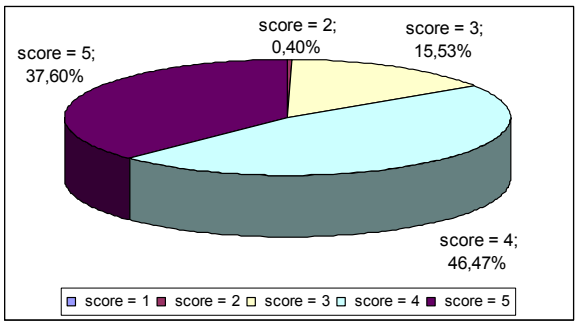



**Figure 9:** *Scores distribution*

The number of time that each one of the member of the panel adopted the different judgment values changes from evaluator to evaluator. But, anybody never expressed a judgment corresponding to 1.

**Table 5:** *Quarter analysis of the scores*

| | Quarter 0 upper bound | Quarter 1 upper bound | Quarter 2 upper bound | Quarter 3 upper bound | Quarter 4 upper bound |
|---|---|---|---|---|---|
| 1 | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% |
| 2 | 0,00% | 0,00% | 0,00% | 0,33% | 2,67% |
| 3 | 8,00% | 10,67% | 14,67% | 17,33% | 29,33% |
| 4 | 38,67% | 42,33% | 46,67% | 50,67% | 57,33% |
| 5 | 24,00% | 31,67% | 37,33% | 44,00% | 50,67% |

The adoption (*Table 5*) of the judgment corresponding to 2 ranges from 0,00% and 2,67%, with a mean value of 0,40%. The first quarter of the 2 occurrences has as upper bound 0,00%, the second

quarter has as upper bound 0,00% (the median value), the third quarter has as upper bound 0,33%.

The adoption of a judgment corresponding to the 3 ranges from 8,00% to 29,33%, with a mean value of 15,53%. The first quarter of the 3 occurrences has as upper bound 10,67%, the second quarter has as upper bound 14,67%, the third quarter has as upper bound 17,33%.

The adoption of a judgment corresponding to the 4 ranges from 38,67% to 57,33%, with a mean value of 46,47%. The first quarter of the 4 occurrences has as upper bound 42,33%, the second quarter has as upper bound 46,67%, the third quarter has as upper bound 50,67%.

The adoption of a judgment corresponding to the 5 ranges from 24,00% to 50,67%, with a mean value of 37,60%. The first quarter of the 5 occurrences has as upper bound 31,67%, the second quarter has as upper bound 37,33%, the third quarter has as upper bound 44,00%.

*Figure 10* shows the normalized percent amplitude of the ranges of values in each quarter, containing each one the five more affine percent occurrences in judgment expressions. In the better case each range is approximately the 25,00%. In the worst case a single range of values occupies the 87,50% of possible values.

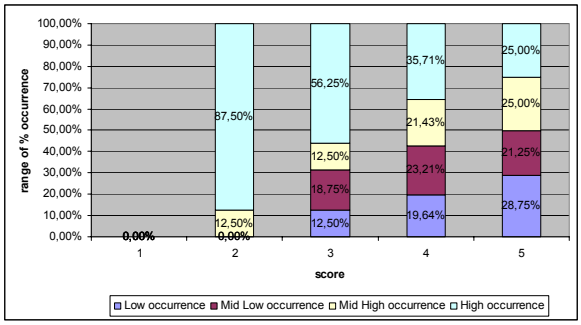


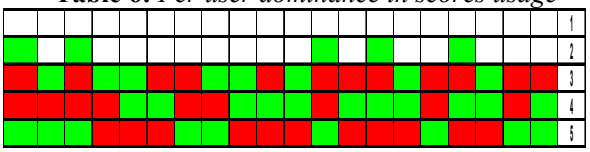

**Figure 10:** *Normalized range amplitude*

The test panel can be also clustered by considering the mean value of percent adoption while considering each single score. The evaluators that adopt a score with a frequency lower than the mean value could be inserted in a group. The evaluators that adopt a score with a frequency above the mean value can be inserted in another group.

The following table (*Table 6*) shows, per rows, in white, cases in which the evaluator did non used at all the corresponding score, in red occurrences above 0,00%, but below the mean value, and in green occurrences above the mean value. As can be seen the evaluators adopted the different scores in different manners.

By taking into account a single evaluator, in the corresponding column, dominance in the use of a single one score or in the use of two scores can be observed, while the remaining scores exhibit lower occurrences. The dominant scores may changes while considering different evaluators.

**Table 6:** *Per user dominance in scores usage*




## 7 Conclusion

This paper presents a detailed evaluation of e-learning activities through satisfaction analysis. The factors that can mainly contribute to quality enhancement are individualized on the base of learners' effective needing. At the purpose, a well-defined survey is considered and investigated in different manners. It allows evaluating not only the quality in use but also concept explanation, content learnability and learner involvement.

The main properties of the learning product are all investigated and sound out by considering different aspects. The results show the usefulness of judgments distribution to evaluate the different properties of the learning object. Critical factors are individualized and highlighted.

The obtained results point out:

a) the quality of the multimedia product to provide learning;
b) the real needing of learners and possible enhancements to the actual implementation within the lifecycle of learning products.

The proposed approach shows the extent to which a learning object is really useful. The survey analysis points out the effectiveness, efficiency and satisfaction with which users can achieve learning results in a particular learning environment.

### *References*

[1] J. T. Mayes, C. J. Fowler, Learning technology and usability: a framework for understanding courseware, Interacting with Computers, 11 (5), pp. 485-497, (1999).

[2] D. H. Schunk, Learning Theories (3rd Ed), Englewood Cliff, NJ, Prentice Hall, (2000).

[3] R. E. Mayer, Educational psychology: A cognitive approach, Boston, Little, Brown and Co, (1987).

[4] R. E. Slavin, Educational psychology: Theory and practice (5th ed.), Boston, Allyn and Bacon (1994).

[5] E. Soloway, Interactive learning Environments: Where They've Come From & Where They're Going, In Proceedings of Computer Human Interaction '96, pp. 384-385, (1996).

[6] 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.

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

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

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

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

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

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

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

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

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

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

[17] 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.

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

[19] A. Jones, E. Scanlon, C. Tosunoglu, E. Morris, S. Ross, P. Butcher, J. Greenberg, Contexts for evaluating educational software, Interacting with Computers, 11 (5), pp. 499-516, (1999).

[20] D. Squires, J. Preece, Usability and learning: Evaluating the potential of educational software. Computers & Education, 27, 1, pp. 15-22, (1996).

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

[22] L. Dringus, An Iterative Usability Evaluation Procedure for Interactive Online Courses, Journal of Interactive Instruction Development, 7 (4), pp. 10-14, (1995).

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

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

[25] D. Squires, J. Preece, Predicting quality in educational software: Evaluating for learning, usability and the synergy between them, Interacting with Computers, 11 (5), pp. 467-483, (1999).

[26] J. C. Cronje, Metaphors and models in Internet-based learning, Computers & Education, 37, pp. 241-256, (2001).

[27] L. Dringus, S. Terrell, Awareness as a metaphor in online learning environments, Paper presented at the International Conference on Technology and Education (ICTE), Santa Fe, New Mexico, March 8-11, 1998.

[28] P. Forcheri, M. T. Molfino, A. Quarati, Design of learner-centred tools for continuous training in SMEs, Education & information technology, vol. 3, pp. 1-16, (1998).

[29] O. Parlangeli, E. Marchigianni, S. Bagnara, Multimedia System in Distance Education: Effects on Usability, Interacting with Computers, 12, pp. 37-49, (1999).

[30] G. Piccoli, R. Ahmad, and B. Ives, Web-Based Virtual Learning Environments: A Research Framework and a Preliminary Assessment of Effectiveness in Basic IT Skills Training, MIS Quarterly, 25, No 4, pp. 401- 426, (2001).

[31] S. R. Terrell, L. Dringus, An Investigation of the Effect of Learning Style on Student Success in Online Learning Environment, Journal of Education Technology Systems, 28 (3), pp. 231-238, (2000).

[32] P.A. Chalmers, User interface improvements in computer-assisted instruction, the challenge, Computers in Human Behaviour, 16, pp. 507-517, (2000).

[33] D. Norman, J. Spohrer, Learner Centred Education, Communication of the ACM, 39 (4), pp. 24-27, (1996).

[34] L. L. Lohr, Designing the instructional interface, Computers in Human Behaviour, 16, pp. 161-182, (2000).

[35] J. J. Pear, D. E. Crone-Todd, A social constructivist approach to computer-mediated instruction., Computers & Education, 38, pp. 221-231, (2002).

[36] D. E. Leidner and S.L. Jarvenpaa, The use of information technology to enhance management school education: A theoretical view, MIS Quarterly, 19, No 3, pp. 265-291, (1995).

[37] S. Campanella, G. Dimauro, A. Ferrante, D. Impedovo, M. G. Lucchese, R. Modugno, G. Pirlo, L. Sarcinella, E. Stasolla, C. A. Trullo, "Evaluating Quality of E-Learning Courses: Investigating on Survey Development", Proceedings of the 6th WSEAS International Conference on Education and Educational Technology, November 21-23, 2007, ISBN/ISSN: 978-960-6766-18-3 / 1790-5117, Venice, Italy, WSEAS publishing, pp. 201-206.

[38] 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.

[39] 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.

[40] G. Dimauro, A. Ferrante, N. Greco, S. Impedovo, 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.

[41] 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.

[42] 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.

[43] 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.