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# Evaluation Factors of Educational Software

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## Abstract

*Hypermedia-based learning is currently a popular instructional delivery system. However, the last decade relevant literature has maintained that most educational software does not meet its promise. One of the reasons for the lack of educational software of high quality is that educational research cannot keep pace with the advances of technology and as a result existing evaluation methods are often inadequate. Yet, the past fifteen years a number of important issues emerged from research on instructional design and system evaluation that can be used from evaluators of educational software. This paper is an attempt to integrate some of these.*

## 1. Introduction

Nowadays, hypermedia systems provide the necessary technology for highly interactive and potentially adaptive learning environments. Yet, in many cases authors of educational hypermedia are often tempted to impress rather than educate the user. As often stated, the failure of so many instructional programs has been the result of an emphasis solely on content, with little regard for principles of instructional design to produce effective, efficient, and appealing instruction. If hypermedia is not well designed, they will create difficulties for users, such as memory overload and divided attention, or they will fail to suit the variety of ways that people work together or alone [1]. One of the main reasons for the lack of high quality educational software is that often research cannot keep pace with the advances of technology and as a result existing evaluation methods are often inadequate. While the paper reports the need for reliable evaluation mechanisms does not intend to provide a template of these. Its intention is to integrate a number of important issues emerged from research on instructional design and system evaluation the past fifteen years, and which should be considered from evaluators of hypermedia courseware that delivers mainly content knowledge. These issues can be used as a basis for the development of evaluation instruments, such as a suitability scale questionnaire.

## 2. Software Acceptability

The overall acceptability of a computer system is a combination of its social and practical acceptability [2]. The term social acceptability is related with the social basis of an educational system. In cases when the basis is teacher-centred, then the software that provides high levels of learner control is possibly socially unacceptable and vice versa. Given that a piece of educational software is socially acceptable, its practical acceptability should be examined through the evaluation of the following sectors: content, presentation and organisation of the content, technical support and update processes and finally, the evaluation of learning. All sectors are equally important, as educational software has to be simultaneously pedagogically and technically sound. Moreover, each sector includes a number of criteria, which should be meet in a satisfactory level, in order to characterise a piece of educational software of high quality. Furthermore, cost-effectiveness should always be examined when similar products seem to have the same educational value.

### 2.1. Content

The information contained within a piece of educational software is the first parameter that should be evaluated according to the following criteria [3, 4]:

– Validity and Authority: Reliable content, Reputable authors, publishers and origin of information.

– Accuracy: Current and error-free information, Bias-free viewpoints and images, Correct use of grammar.

– Appropriateness: Concepts and vocabulary relevant to learners' abilities, Information relevant to age group curriculum, Interaction compatible with the physical and intellectual maturity of intended audience.

– Scope and Coverage: Information of sufficient scope and depth, Logical progression of topics, Variety of activities, with options for increasing complexity.

### 2.2. Presentation and Organisation of the Content

The factors associated with this sector are the pedagogical ones that concern with learning and instructional design theories and the interface design factor.

**2.2.1. Pedagogical Factor.** This is a complicated factor as there are different beliefs on how humans learn. However, cognitive theories stress that learning is an active, constructive, cumulative, self-regulated process in which the learner plays a critical role. Moreover, current instructional theory focusing on constructivist approaches depends on information access and learning environments that encourage free interaction with information.

The agreement with the principles of an instructional design theory depends heavily on the subject matter. In addition, teacher's belief is of great importance, especially in cases when the educational software is part of the curriculum. Reigeluth and Squire suggest the integration of instructional design theories in the form of an 'umbrella theory' in order to decide when to use a particular one [5].

Nevertheless, the two core elements that are important in all educational settings are *motivation* and *structure*, which largely define the *instructional nature* of an information environment. A typical way to motivate the learner is to inform him/her what will s/he achieve at the end of the instruction by stating the aims and objectives [6]. As far as the structure is concerned, that is how to organise instructional information, again depends on the subject matter. However, in cases when the instructor wants to permit the learners to advance, review, see examples, repeat the unit, or escape to explore another unit, Jonassen suggest the network structure as most appropriate, which implies an explicit organisation or arrangement of nodes and associative links [7].

In hypermedia learning systems another important element is *learner's control*, which is primary in the design of interactive learning as it allows students to tailor the learning experience in their own individual needs. However, there are dangers in surrendering too much control to the user. Low-ability students may get confused when control depends on a wide range of options [8, 9]. The high level of learner control may result in disorientation and distraction. The amount and type of learner control depends on the learner characteristics (age and cognitive capabilities), content, and the nature of the learning task [10]. Content that must be mastered and unfamiliar tasks often requires more program control, compared to content with no qualified mastery levels or familiar learning tasks. Learner control is more appropriate than program control when learners are more capable and are familiar with the learning task. Moreover, advisement is provided to assist them in making decisions and control is used consistently within a lesson [11]. In general, the more control is given to the learners, the more feedback about their decisions should be given [12].

Moreover, the issues of *accommodation of individual differences*, and *co-operative learning* are highly important in the effectiveness of hypermedia-based learning. In most education contexts learners are not homogeneous in terms of prerequisite knowledge, motivation, experience and learning styles. Also evidence suggests that when hypermedia learning systems are structured to allow co-operative learning, learners benefit both instructionally and socially.

**2.2.2. Interface Design Factor.** *Interactivity - Navigation - Feedback*: Interactivity in instruction comprises the nature of the activity performed by the technology and the learner, as well as the ability of the technology to adapt the events of instruction in order to make that interaction more meaningful [13]. It is important to design as much meaningful interactivity as possible into instructional software. Guidelines for increasing interactivity in instructional programs are [14]:

– Provide opportunities for interaction at least every three or four screens.

– Chunk the content into small segments and build in questions, reviews, and summaries for each segment.

– Ask students to apply what they have learnt rather than memorise. Also, use rhetorical questions during instruction to get students to think the content and consider designs where the learner discovers information through active exploration.

The amount of navigational assistance needed is a function of the size of the knowledge base, the usefulness of navigational aids that are already part of the authoring software, and the types of links the software allows [15]. Navigation may be facilitated when users can [16]:

– Back up a node at a time, Review their paths and immediately re-access any previous node and get

– Search for information with key words or indexes and use maps and tables of contents to see the overall structure of the knowledge base.

– Get 'fish eye' views indicating the names or contents of nodes neighbouring the one currently displayed.

A courseware should promote interactivity by assisting access to some or all of the following options [17]:

– Help key to get procedural information.

– Answer key for answering a question.

– Glossary key for seeing the definition of any term.

– Objective key for reviewing the course objectives.

– Content map key for seeing a list of learner commands or options available and overview of introduction key for reviewing the introduction to the unit.

– Menu key for exiting the lesson and returning to the menu and exit key for exiting the course. Also, summary and review key for reviewing whole or parts of the lesson.

– Comment key for recording a learner's comment.

– Examples key for seeing examples of an idea and finally keys for moving forward or backward in a lesson and for accessing the next lesson in a sequence.

The basic factors that can determine the effectiveness of feedback are the type and frequency of feedback given and the delay between feedback and instruction [18]. Feedback is closely related with the issue of interaction, as action without feedback is completely unproductive for a learner [19]. Many actions require more extended extrinsic feedback than confirmation feedback. Simple answers such as right or wrong cannot provide information about how learners should correct their performance. On the contrary, correct response and explanation feedback would give the learners information about how to adapt and correct their performance. Some basic guidelines on performance feedback are [14, 18]:

– Provide feedback immediately after a response.
– Vary the placement of feedback according to the level of objectives. Provide feedback after each response for the learning of lower level objectives, and at the end of the session for the higher level ones.
– Provide feedback to verify the correctness. For incorrect responses, give the student information about how to correct their responses, or hints to try again.
– If possible, allow students to print out their feedback.

*Screen Design*: Screen design is an important evaluation factor. Different screen elements should be used to present stimulating information that will motivate and assist the learners in retaining and recalling the information. The psychological limitations to consider when designing hypermedia learning systems include: (a) *Memory load*: i.e. how many different control icons is it reasonable for learners to remember at any one time? (b) *Perception:* i.e. what colours and fonts provide the best readability?, and (c) *Attention:* i.e. how can the users' attention be drawn to information that is relevant, when there is a lot of different information on the screen? [1]. Researchers have produced screen design guidelines and the following section is an attempt to summarise the most important [20,21,22,12]:

**Use of Space**

– In western cultures, people tend to scan a display in the same way as a printed text is read. Also, the eye will naturally move to a larger image before a smaller; to a moving object before a static one; to a colour before B/W.
– Areas demanding action are better placed near the centre of the user's attention.
– A 'full' screen can make difficult demands on the concentration of the user.

**Text**

– The use of typeface should be consistent.
– Readability suggests for continuous reading that the character size should be around twelve points with line spacing of one and half lines.
– Headings could be the next size up from body text in a different style or colour from the main body of text.
– Large quantities of text are difficult to read and understand on a computer screen. Line lengths of about eight to ten words appear to be the optimum.
– When a large amount of text is to be displayed it is preferable to split it meaningfully into several screens.
– Right justification of text should be avoided.
– Flashing text is difficult to read, but is appropriate for vital information, and finally, text enclosed within a box is not as easily read or comprehended as plain text.

**Colour**

– Text and background colours should be chosen carefully aiming to maximise contrast.
– Colour is a powerful means of highlighting information compared to the use of shapes but use of excessive amounts does not serve to direct attention. Consistency in the functional use of colour is important.

**Graphics**

– A high contrast between graphics and background should be retained.
– Pictures not covered by the information in the text will not enhance learning. Also, diagrams are useful only if the information in them is used meaningfully.
– Pictures can help learners to understand and remember and should be placed near the text that support.

**Animation/Video**

– Movement alerts attention, therefore animation will be the centre of attention; so if another event of importance is occurring on screen it may be ignored.
– Movement should be employed to reinforce connections and relationships.
– When the animation contains vital information it is important to provide an option to repeat the sequence.
– More than one animation at a time in the same screen would result in confusion.
– Video should be used to demonstrate devices in motion or to present 'real life situations' and not for imparting abstract concepts and philosophies.
– Video is least effective when simply used to show a speaker, and is less effective than the use of sound alone.
– Segments of video are better kept short.

**Audio**

Although audio is not visual information, is examined here, as it is an important part of the computer interface.

– When information is aural (i.e. language learning programs) the use of sound is vital. In other cases should be an option rather than a necessity. Also, it provides feelings of immediacy adding to the user's involvement.
– Sound can be used to gain attention and to reinforce information, which is also being presented graphically.

## 2.3. Technical Support and Update Process

It is a common belief that new knowledge comes to life every day and therefore educational instruments should be regularly updated. The rapid growth of technological innovations is also important, as technology is the delivery platform of educational software. Therefore the value of the information content and the product over time should be examined. Some issues to consider are [3]:

– Durability of the content over time.
– Updating, modifying and adding procedures.

– Portability and technical coverage of the product.

When the educational software is web-based, then *system* and *site* integrity should be evaluated as well by examining the stability of links, the availability of mirror sites, the adequacy of administration and maintenance, the regular updating and finally archived information.

### 2.4. Evaluation of Learning

Marchionini [23] argues that the interactivity of hypermedia systems provides learners with access to vast amount of information in varied forms, control over the process of learning, and the potential for collaboration with the system and other people. Such empowerment of learners forces evaluators of learning to adopt a broad-based set of methods and criteria to accommodate 'self-directed' learning. He proposes a 'multi-faceted' approach to the evaluation of hypermedia based learning that address both the outcomes and the processes of learning.

**Learning Outcomes**. Performance tests or assignments are typically used to judge the quality and the quantity of learning as resulted scores are typically interval or ratio values (or can be transformed as such) so that powerful inferential statistical analysis can be employed to make generalisations about uniform impact. Three types of performance tests can be used: pre-tests to determine learning outcomes prior to the intervention, post-tests and delayed post-tests to determine learning outcomes after the intervention.

**Learning Process**. The learning process refers to the usability of a product and should be evaluated by observing and measuring the end-users attitudes. Usability is usually associated with five parameters [2]: (1) Easy to learn: The user can quickly get some work done with the system, (2) Efficient to use: Once the user has learnt the system, a high level of productivity is possible, (3) Easy to remember: The casual user is able to return to using the system after some period without having to learn everything all over, (4) Few errors: Users do not make many errors during the use of the system or if they do so they can easily recover them, (5) Pleasant to use: Users are subjectively satisfied by using the system; they like it.

## 3. Conclusion

The establishment of reliable evaluation mechanisms could contribute drastically in the decrease of low-quality educational software. However, these mechanisms should take into consideration critical issues emerged from research on instructional design and system evaluation. In addition, evaluators should consider that an educational software package is part of a greater educational environment. Therefore, it should be meaningfully embedded in the curriculum in order to contribute significantly in the learning experience.

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