Improving hypermedia teaching resources - New designs for e-learning environments

Inma Rodríguez-Ardura, Ana I. Jiménez,
Gisela Ammetller and M. Carmen Pacheco
Internet Interdisciplinary Institute,
Open University of Catalonia (Universitat Oberta de Catalunya or UOC, Barcelona, Spain)

Abstract: This study aims to offer a set of empirically-based guidelines for the design of hypermedia teaching resources used in computer-mediated educational environments. These criteria are: incorporating additional tools to guide and aid navigation; limiting the use of hypertext structures; the intensive use of various formats (multimedia); and the integration of two editions of the material adapted to two different contexts of reading and study (online and off-line). The suitability of these criteria is then determined by developing an integrated set of hypermedia teaching materials based on them and testing the materials in a real e-learning context. The results indicate that the students perceive the new educational material based on the proposed criteria more favourably than the existing teaching resources used in the same learning environment.

Keywords: Teaching resources; e-Learning; Hypermedia; Higher education.

1 Introduction

In university education based on e-learning systems, the teaching resources are a critical element. This is because in order for the teaching and learning processes to develop properly in this type of environment, the student must interact dynamically with the content. The educator, rather than focus on disseminating information, becomes a facilitator of learning (Kettner-Polley, 1999), responsible for designing and producing teaching resources or materials adapted to the environment, and guiding and advising the students on how to use the material correctly.

Despite the importance of the teaching resources in e-learning initiatives, scholars and higher education institutions alike still have much

to learn about the criteria guiding their design and development. Indeed, the literature provides ample evidence that such initiatives do not always work: students often end up feeling "lost" among all the material available to them (Burbules and Callister, 1996), make only a linear reading of the most important aspects (Light *et al*., 1997; Karuppan, 2001), or end up printing the material on paper (Crook, 1997; Ward and Newlands, 1998) and doing the reading, reflection and work outside the environment specifically designed for them.

To date, however, the literature has provided little evidence about the right medium, structure, format and contents for material in e-learning environments (e.g., Atwong and Hugstad, 1997; Karuppan and Karuppan, 1999; Ryan *et al*., 2001; Peterson *et al*., 2002). Thus, the current work aims to shed light on the design criteria for teaching materials adapted to e-learning environments. With this objective, the work has reviewed the literature examining the role of the teaching resources in online education, uncovering their main advantages and disadvantages for the students in their knowledge building process. The outcome of this review is a set of criteria for the design of teaching resources. Materials based on these criteria are then developed and tested in a real e-learning environment.

The rest of this work has the following structure. The next two sections review the literature on teaching resources in computer-mediated educational environments. This review makes it very clear that there is a need to define new design criteria that contribute to overcome some of the limitations found in the literature and at the same time exploit the benefits. The fourth section proposes four initial design criteria that are used as the basis for an integrated set of teaching resources for a specific e-learning environment. Section 5 describes how this set of resources is developed and tested in a real e-learning environment, and the results of the survey of students using the materials. The final section offers some concluding remarks.

2 Why use hypermedia teaching resources?

E-learning environments are increasingly incorporating teaching resources in hypertext format that also include multimedia resources. And indeed, this type of resource has a number of important advantages in education. These include the fact that the students have more control over their own learning process (Beasley and Smyth, 2004). In these environments the students themselves can decide where, when and for how long they wish to study (Hill, 2000), as well as the order, depth and speed with which they will explore the contents, on the basis of their capabilities, skills and needs (Beasley and Smyth, 2004). Moreover, and

because the hypertext format allows various navigation options and so allows the students to explore and analyse different perspectives within which to solve a particular problem (Jonassen, 1992), the students can then develop a critical understanding of the domain (Beasley and Smyth, 2004; Berger and Topol, 2001) and identify the most appropriate solution in each particular situation. They can then build their knowledge through a process of personal reflection, debate with others (educator and fellow-students), and decision about the information they wish to incorporate into their cognitive structure (Jacobson and Spiro, 1995). On the other hand, information is organised associatively in hypertext, similarly to how the human brain works (Bush, 1945; Nelson, 1967). Thus, the students can go beyond linear reading with hypertext (Clark III and Flaherty, 2002). Providing they undertake a detailed exploration of the various linked elements, the learning can develop in a more natural and productive way (Nanjappa and Grant, 2003).

Hypertext teaching resources often incorporate various multimedia elements in order to complement or expand on the information given (Najjar, 1998), or to help the students understand the already-existing material (Bell and Winn, 2000). Including this type of resource can help make the e-learning environment more realistic (Steuer, 1992), and improve the individual's cognitive capacity. In fact, authors such as Elliott and Hall (2002) recognise the existence of individuals whose learning capacity increases when sensory resources are used. Thus, students with a strong visual memory can learn more spontaneously and naturally when the material includes colour, graphics and sound.

3 Limitations in effective use of hypermedia resources

Hypermedia resources have much potential, but learners often do not exploit it fully. Thus, although students tend to value these resources highly (Gubern and Rodríguez, 1997; Rodríguez and Ryan, 2001), they often do not interact properly with them, and so fail to obtain the expected results.

In some cases students spend too little time exploring the material in depth, negatively impacting their knowledge construction process. The students, trying to study in the shortest possible time, sometimes explore the different options available to them to only a shallow level, and so end up obtaining an incomplete view of the possible solutions available (Hiltz, 1997; Beasley and Smyth, 2004). In other cases, the students carry out the process outside the e-learning environment: they revise the teaching materials on paper (after directly printing the hypertext they are given),

and attempt to read the material linearly, though the material was not designed to be used in this way (Crook, 1997; Ward and Newlands, 1998).

Authors such as Crook (1997), Ward and Newlands (1998), and O'Hara and Sellen (1997) confirm that many students prefer the paper medium because it gives them considerable flexibility about when and where to study, and the possibility of writing comments and notes on it, underlining text, and so on. Likewise, Ryan *et al*. (2001) and Beasley and Smyth (2004) find evidence that students find it difficult to choose between the numerous navigational paths and are apprehensive about adopting an active role, which is consistent with the risk of feeling lost in "hyperspace" (Burbules and Callister, 1996). Ryan *et al*. (2001) also find that this preference for paper is stronger in the final stages of the learning process (revision and consolidation) than in the earlier stages, when the students are more predisposed to read and conduct a general exploration of the content seated in front of the computer screen.

4 Design criteria – proposals for improvement

Criterion 1: Simplification of hypertext structure

The evidence about many students' tendency to adopt a non-active role when exploring hypertext (Hiltz, 1997), to read the material linearly or sequentially (Beasley and Smith, 2004), and to not consult all the resources and tools available to them (Light *et al*., 1997; Karuppan, 2001), although they are sufficiently trained to study online (Rodríguez *et al*., 2006), leads the research team to propose various design criteria to simplify the structure of the hypertext.

This first type of criterion involves, on the one hand, establishing some limits to the presence of internal links (those between different parts of the material). Thus, the proposal is to include only those internal links that are absolutely essential (i.e., those that help students to compare concepts or relate contents).

On the other hand, this does not preclude continuing to provide systematically all types of link to external resources (articles and reading material cited, databases, etc.). But these resources should open in a second navigation window so the students do not lose sight of the material and their navigation is consequently not disrupted.

Likewise, and in order not to fragment the contents excessively between a large number of pages, the authors recommend ignoring the usability norm limiting the length of web pages (and hence the use of scrolling) as far as possible (Nielsen, 2000). This proposal means not establishing a

maximum page length a priori; each block of knowledge will be allocated to a page regardless of the length of page that it requires.

Criterion 2: Additional instruments to guide and aid navigation

Second, and to prevent, as far as possible, the students from feeling lost (Burbules and Callister, 1996) or from perceiving that they could be overlooking some "essential" content (Beasley and Smith, 2004), the next proposal is to provide a wide range of tools to aid in the navigation: navigation menus (vertical or horizontal), clickable indexes of content and contextual orientation tools.

Criterion 3: Intensive use of various formats (multimedia)

In view of students' favourable disposition towards the inclusion of multimedia elements (Ryan *et al*., 2001), restricting this type of resource does not seem wise. On the contrary, the next proposal is to make intensive use of all resources that increase the number of sensory dimensions presented simultaneously (Steuer, 1992). This will aid in the perception, comprehension and recall of contents (Honebein *et al*., 1993).

Criterion 4: Integration of two editions adapted to two different contexts of reading and study

Conventional media (such as printed materials) and the new hypermedia platforms (web sites, CD, DVD, etc.) are both potentially useful to students. But each has specific and unique advantages and limitations. Thus, the next proposal is to have a harmonious and consistent integration of both types of medium that contributes to achieving the educational objectives established, rather than treat the two as mutually exclusive.

On the one hand, the proposal is to treat the hypermedia resources as the preferential medium in the early stages of the learning process and consequently to produce a "navigable version" of the teaching resources. This version of the material will have numerous multimedia resources to capture the students' interest and encourage them to enter and explore the content. On the other hand, and because many students need a medium adapted for subsequent analysis and revision, that permits underlining and adding notes, that permits a linear reading, and that is easy to use in any daily situation, a "printed version" of the teaching resources should be

produced on paper. This version will look like a textbook and include all the information provided in the "navigable version".

There must be a complete correspondence between the contents of the two versions, so transcripts must be written of every multimedia element in the "navigable version" (voice-over, dialogues in animations, etc.) regardless of the medium, and made available in the "printed version".

The aim of the integrated use of both media is that the advantages of one medium will compensate for the limitations or weaknesses of the other. Moreover, this duplication is justifiable because the students who are the most predisposed towards online education can experience this process entirely through the "navigable version" of the material if they wish.

5 Implementation and testing of design criteria

5.1 Description of the e-learning environment and process of developing the teaching resources

Teaching materials based on the design criteria proposed above have been developed and tested within a university framework. Specifically: the Open University of Catalonia (UOC, *Universitat Oberta de Catalunya*), widely considered for its work in e-learning not only in Europe but across the world, is the institution chosen for this work. The UOC was created in 1994 in Barcelona (Spain). It is at the centre of an extremely diverse university community, with around 43,000 students from more than 45 countries. These individuals all share the common goals of acquiring knowledge, personal enrichment and life-long learning. They all use IT to interact, thereby consolidating a growing and dynamic online community.

On the basis of the proposed design criteria the authors developed a set of teaching resources for the *Foundations of Marketing Management* course taken by students studying for various qualifications (diplomas and degrees) in Economic and Business Studies at the University. This implementation process, which lasted for two years (from February 2002 to January 2004), began with the preparation of a plan of publications for this particular course, and a methodological guide specifically for the authors of the material. After the formal author's commission was defined, the material authors were recruited and trained. These authors were responsible for producing the teaching resources in accordance with the instructions in the authors' guide and the recommendations of the coordinator lecturer. When the draft manuscript was complete, the coordinator revised the content from the pedagogical and scientific perspective, and the editorial team revised the text and the style. After

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these revisions the prototype was technically implemented, which again required it to be reviewed by the coordinator lecturer.

In parallel, the teaching plan of the course was drawn up, and the instructors for giving the course were chosen and trained, with special emphasis on aspects concerning the use of the hypermedia material.

5.2 Methodology

To obtain information about the students' degree of acceptance of the new teaching resources developed on the basis of the design criteria proposed here, and compare the students' perceptions and attitudes towards this new material with their perceptions and attitudes towards the existing resources in Economic and Business Studies, a survey was used.

The measurement instrument, which was based on Ryan *et al*. (2001), consists of seven items, each centring on one of the following variables or factors: 1) positive general assessment of the multimedia elements; 2) perceived ease of accessing the content; 3) access to a wide range of resources (practical cases, bibliography, additional reading, examples, etc.); 4) up-to-date content; 5) ease of playing an active role with the material (deciding navigational paths, order of study of materials, etc.); 6) suitability of material for objectives of course; and 7) perceived ease of carrying out the learning process. All these items are measured on 5-point Likert-type scales, ranging from 1="totally agree" to 5="totally disagree". The questionnaire also includes an open question inviting the respondents to give their opinion about the material, as well as a specific item about the students' preferred role (autonomous and dynamic) in their learning process.

The questionnaire, which was self-administered online, was part of the university's survey of student satisfaction with the institution. It was distributed by e-mail to the 1,812 students studying for the various qualifications in Economic and Business Studies who were using the new material in the academic semester starting in February 2004. The students had one week to respond to and then return the questionnaire, also by e-mail.

A total of 76 completed questionnaires were received, which represents a response rate of 4.2%. In accordance with the university's policy in communications by Internet and data protection, the research team abstained from contacting non-respondents to request collaboration a second time.

5.3 Results

The results show that for all the items considered, the students have on average a more favourable opinion of the new teaching resources in *Foundations of Marketing Management* than the existing resources in Economic and Business Studies. The results of the paired-sample t-test show the existence of significant differences (at the 95% level) for the means of the two variables measuring general evaluation of the multimedia resources provided and suitability of the material for the objectives of the course.

Table 1: Items and mean evaluation of new materials and rest of materials in Economic and Business Studies

	Materials for Foundations of Marketing Management	Rest of materials in Economic and Business Studies	t	p
Positive general evaluation of the multimedia resources	2.33	2.48	-2.238	0.036
Ease of access	2.14	2.52	-1.436	0.164
Wide range of resources	2.07	2.65	-1.401	0.175
Up-to-date content	1.93	2.41	-1.551	0.135
Ease of playing active role with material	2.38	2.52	-0.723	0.477
Suitability for objectives of course	2.28	2.84	-3.049	0.006
Ease of learning	2.52	2.75	-0.862	0.397

In order to analyse whether the evaluation of the new teaching resources is influenced by individuals' predisposition to adopt an active role in their learning process, the sample is segmented into two groups according to whether the students are totally or quite in agreement with playing an active role (58%), or whether they have zero or a low predisposition or are indifferent to adopting such a role (42%). The analysis of variance (ANOVA) reveals significant differences between both segments in each of the variables examined. Individuals who prefer to play an active role in their learning process evaluate the various aspects contemplated in the new teaching resources more positively.

Table 2: Mean evaluation of new materials by student's preferred role

	Active role	Non-active role	F	p
Positive general evaluation of the multimedia resources	1.98	2.88	7.900	0.007
Ease of access	1.88	2.52	5.556	0.021
Wide range of resources	1.83	2.41	5.515	0.022
Up-to-date content	1.65	2.31	5.626	0.021

	Active role	Non-active role	F	p
Ease of playing active role with material	1.93	3.00	13.450	0.000
Suitability for objectives of course	1.79	2.96	16.980	0.000
Ease of learning	2.28	2.86	4.341	0.041

The next test is to determine whether the students' attitude towards adopting an active role in their learning process, and their perception of certain characteristics in the teaching resources, favour the use of the material in a more autonomous and dynamic way. For this, a multiple linear regression analysis was used. Prior to this it was necessary to ensure that the independent variables are not correlated among themselves. The model obtained has a goodness of fit of 54.4% (R^2=0.544, adjusted R^2=0.522), limited multicollinearity between the independent variables for the OLS estimators (the tolerance values are between 0.741 and 0.847, and the variance inflation factors are between 1.181 and 1.350), and a low autocorrelation between the residuals (the Durbin-Watson statistic equals 1.931). The model is significant globally (the ANOVA gives a value p=0.000). The results show a significant relation between the independent variables considered with respect to the dependent variable (ease of playing active role with material). Thus, the students' proactive attitude and the availability of material providing access to a wide range of resources and including adequate multimedia elements contribute significantly and positively to the students' perception that using the materials allows them to play an autonomous and dynamic role in their learning process in this course.

Table 3: Regression analysis

	Non-standardised coefficients	Standardised coefficients	t	Sig.	Collinearity	
					Tolerance	VIF
Constant	0.058		0.198	0.844		
Positive general evaluation of the multimedia resources	0.315	0.325	3.266	0.002	0.741	1.350
Wide range of resources	0.555	0.443	4.754	0.000	0.847	1.181
Favourable predisposition to adopting active role	0.191	0.191	2.004	0.049	0.808	1.238

Analysis of variance	Sum of squares	df	Mean squares	F	Sig.
Regression	60.533	3	20.178	24.655	0.000
Residual error	50.740	62	0.818		

Analysis of variance	Sum of squares	df	Mean squares	F	Sig.
Total	111.273	65			

Finally, the responses to the open question reveal the importance of the printed version of the material. The students affirm that they have a very high opinion of the use of the multimedia, but at the same time, the printed version of the material is absolutely essential to them. Every single respondent cited this point. The students mention that studying from the computer screen is hard work and the navigational version is not portable, so that they prefer to use the printed version in the final stages of their learning process.

6 Final discussion and concluding remarks

It is widely recognized that ICT are beneficial in teaching and learning processes because they make traditionally rigid processes more flexible and improve the work of both educators and students. Nevertheless, developing educational strategies based on the use of ICT makes certain elements such as the teaching resources relatively more important.

Hypermedia resources are particularly important because they are highly adaptable to the preferences, needs and situations of each student, as well as for their impact on the way in which the educational process is conceived and developed. The educator, now a facilitator of learning, directly interacts with the teaching material, being responsible for its design and elaboration. On the other hand, the students become active agents in the learning process, establishing the path, the depth and the rhythm of their own learning.

Various studies point out the benefits of using hypermedia teaching materials in educational processes. But they also find that students have some difficulties in using such resources effectively (Crook, 1997; Ward and Newlands, 1998; Ryan *et al*., 2001; Beasley and Smith, 2004). For example, the students often have difficulty in changing their traditional study habits, are insecure and confused during navigation and online work, or perceive the material to have poor usability. These disadvantages are particularly significant in the final stages of the learning process when the students want to revise and consolidate the concepts learnt.

Thus, the current work has identified a number of criteria for the design of hypermedia teaching resources that should help overcome the difficulties discussed. These criteria include the incorporation of additional tools of contextual orientation and aids to navigation; limiting

the fragmentation of content through hypertext systems; an intensive use of teaching resources in various formats (multimedia) to stimulate different sensory perception pathways; and the integration of two editions of the material that contain identical content but are adapted to two specific contexts of reading and study (online and off-line).

The research team developed and tested a set of teaching materials based on these criteria for the *Foundations of Marketing Management* course, which was subsequently taught to students studying for various qualifications in Economic and Business Studies at the Open University of Catalonia.

The material was tested on a sample of these students. The analysis carried out shows that the students tend to have a higher opinion of the new teaching resources than the existing teaching material. Moreover, the students' perception of the new material improves significantly when they have a favourable general predisposition to adopt a more active role in their own learning process. Finally, the results show that having a proactive attitude, and the inclusion of design criteria like the ones defined (intensive use of multimedia, wide range of teaching resources), encourage students to adopt more autonomous and dynamic behaviours more in accordance with computer-mediated educational models.

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