

e-Learning in Context: The Role of Semantics, Metaphors, and Culture in Computer-Aided Instruction

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Abstract

Learning involves the creation of semantic associations, plus the application of behavioral metaphors. The efficacy of associations and metaphors depends heavily upon the context within which learning is attempted. Context enhances meaning by allowing the association of known information to that which is newly introduced. In the process, the meaning of both old and new knowledge is transformed.

Users of computer-aided instruction (CAI) software experience increased cognitive loads if the stimuli they receive from their systems are not suitable to the context in which they use their systems. Increased cognitive loads lead to inefficiencies in learning and user frustration. Therefore, a close match between the context of use and the context anticipated by CAI software is important to learning success and user satisfaction.

Following a description of long-term memory encoding and its relationship to context, this paper discusses five dimensions of culture that impact the effectiveness of multimedia CAI systems. The case is made that creators of such systems must accommodate cultural differences between educational software designers and the intended users of CAI (their customers), if effective learning and recall are to be achieved. Finally, examples of the implications for practice are provided.

Objectives of the Paper

The objectives of this paper are

1. To examine the tight coupling between context and learning, due to the role of semantic associations and metaphors in the memory encoding process;
2. To establish the inevitable effects of increased cognitive loads experienced by learners when inappropriate context impairs encoding;
3. To link learning inefficiencies due to increased cognitive loads to the design of computer-aided instruction (CAI) software;
4. To propose that differences in cultural context between CAI users and the developers of such software can degrade the effectiveness of multimedia CAI packages, and
5. To provide examples of the implications for practice.

Significance

The significance of this paper is its attempt to forge logically defensible links between established memory encoding and learning theory on one hand, and the effects of mismatched cultural context within multimedia CAI packages, on the other.

To the extent that this attempt succeeds, this paper provides one means to apply a substantial body of cognitive psychology and internationalization research to the practice of creating effective software for learners in target cultures, thereby improving both the software and our understanding of the effects that it creates.

Theoretical Underpinnings

The precept of this paper is that a tight coupling between context and learning, based on associations and metaphors used during memory encoding, makes it essential that cultural differences among e-learners and between developers and e-learners¹ be accommodated when creating CAI packages. To do otherwise risks productivity losses, sub-optimal learning, and e-learner dissatisfaction.

Figure 1, a Contextual Encoding Linkage Model, was developed for this symposium to illustrate the coupling between learning and context, and its impact upon e-learning. As with any newly minted model, it requires validation and refinement. The model is based on the author's interpretation of literature in cognitive psychology and internationalization, and is offered as a starting point in exploration of a very complex area of human-computer interaction: cross-cultural effects in computer-mediated instruction. More broadly, it could be the basis for discussion of any situation in which cultural context affects user expectations of and reactions to technology.

Contextual Encoding

It is established in the cognitive psychology literature that "Any learning task occurs in a particular context which is defined by a combination of the external environment and the learner's own internal environment..." and that "...we utilize past knowledge and experience in learning" (Eysenck, 1984, pp.123-124). This internal/external dichotomy is represented in Figure 1 by the dark vertical line separating "Internal" (cognitively based) aspects of learning from those that are "External" (stimulus based).

Over the years, several studies have verified that retention (memory) can be as much as 50 percent higher when learning and recall take place in the same environment (context), compared to when recall is attempted in an environment different from that in which initial learning occurred. Similarly, studies have shown that recall is improved if a person's mood or mental state is similar to that experienced during initial learning. Arguably, one example of mood or mental state is

a user's feeling of comfort with an experience because it matches expected cultural norms. This paper makes the case that cultural context (labeled "Variable Stimuli" in Figure 1) is a neglected but significant factor in the environment, one which can be expected to affect users' recall after e-learning. Therefore, if the cultural context of an e-learning application seems environmentally compatible with the user's "home" culture, he or she should be more comfortable during learning and should be able to retain learning better than if discomfort is felt.

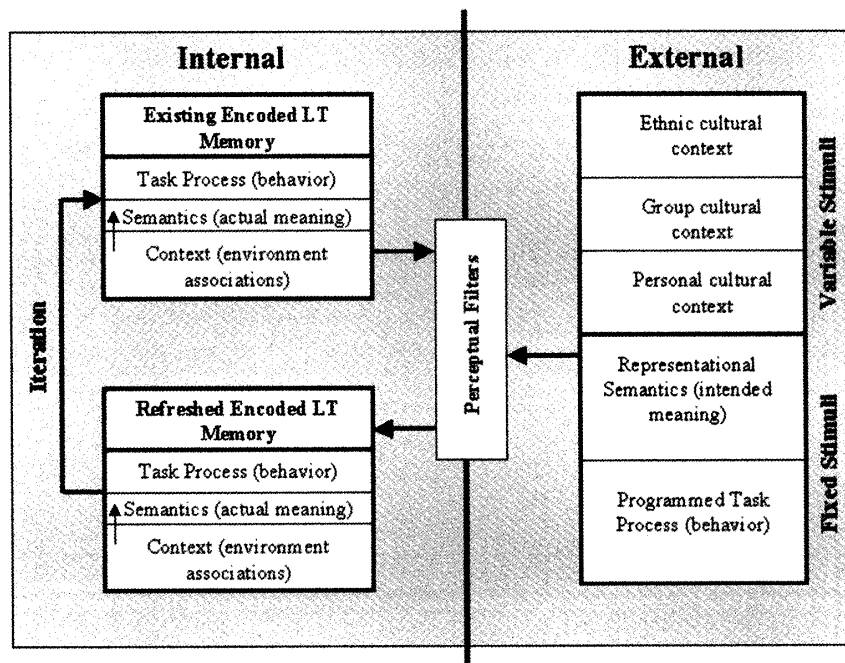


Figure 1. Contextual Encoding Linkage Model

Semantic Association and Metaphors

One set of cognitive mechanisms underpinning context's ability to aid recall is the use of semantic associations and metaphors. These mechanisms are important to effective operation of individuals' long-term memories (memories that persists for more than a few seconds). In a classic definition, Tulving (1972, p.386) defined semantic memory as

...a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meanings *and referents*, about relations among them, and about *rules, formulas, and algorithms* for the manipulation of these symbols, concepts, and relations. (emphasis added)

In essence, semantic memory forms a cognitive tree of associations that helps individuals recall and associate knowledge elements encoded from past experience, when those elements are needed for current perception and behavior. Such cognitive trees are important to the understanding and proper encoding of new learning,

because new knowledge is stored and associations are built in reference to the existing semantic structures. The “referents” underscored in the Tulving definition of semantic memory include external ethnic, group and personal contexts. At a future time, individuals will associate the contexts of use perceived at present with stimulus symbols (e.g., “Representational Semantics”) experienced in e-learning systems at present.

Associations based on metaphors are similar to those formed using semantics, except that instead of relating to knowledge per se (e.g., about a topic or learning context), metaphors relate to task processes or behavior. Metaphors help e-learners to act appropriately when using CAI packages, by “making them [appropriate behaviors] similar to actions, procedures and concepts that are already known” (Carroll, Mack & Kellogg (1988), p.67). Metaphors exploit an e-learner’s prior knowledge of familiar activities by allowing him or her to model behavior that is needed currently on task processes recalled from familiar past situations. If tasks are accomplished differently from one culture to another, and CAI design does not take these differences into account, metaphor breaks down as an effective e-learning mechanism.²

Cognitive Load

Human beings are limited in their ability to process substantial amounts of complex information (i.e., they are “limited information processors” (Simon, 1957)). Limitations on processing throughput are due in part to the problem of cognitive load. Individuals cannot recognize, interpret and associate all of the data entering through their senses, so they must use Perceptual Filters (sometimes termed “lenses”) to reject some data and process others.

Perceptual Filters, as shown in Figure 1, combine an individual’s Existing Encoded Long Term Memory with current External Stimuli. Expectations play an important role in the filtering and interpretation of information as it exits the Perceptual Filters and is encoded as new or “Refreshed” long term memory. This paper proposes that cultural expectations of e-learners who use CAI packages developed in other cultures can distort information, if instructional material does take user contextual expectations into account..

A mismatch between expected versus actual cultural context forces additional mental processing, as the learner attempts to adjust perceived differences in cultural models between their preconceptions and the world as represented in a CAI package. Such additional processing increases cognitive load, which in turn can cause distortions in the encoding of information presented. The individual struggles subconsciously to manage the encoding burden (Sweller, 1994).

Another example of perceptual filters at work might be difficulties in semantic coding brought about by language effects, postulated by the “Sapir-Whorf Hypothesis”. According to this theory, the mere fact that fine gradations in meaning

have no word analogs in a person's language may cause such distinctions to be lost as the individual encodes communication.³ The more far-reaching aspects of this theory have been disputed by modern psycholinguists, but its implications for learning remain:

Language may not determine the way we think, but it does influence the way we perceive and remember, and it affects the ease with which we perform mental tasks. Several experiments have shown that people recall things more easily if the things correspond to readily available words or phrases. And people certainly find it easier to make a conceptual distinction if it neatly corresponds to words available in their language. (Crystal, 1987)

The Contextual Encoding Linkage Model

Having laid the groundwork with a basic explanation of contextual encoding, we now turn to an explanation of Figure 1, the Contextual Encoding Linkage Model. This model, though applicable to many forms of technologically based intercultural communication, is used here as the foundation of an argument in favor of cultural sensitivity in the design of e-learning software.⁴

As with any model attempting to represent the complex interactions between humans and their environment and within the mind itself, Figure 1 is hopelessly oversimplified. However, simplification is essential if we are to deal effectively with a limited but important set of concerns in the development of effective e-learning systems.

Internal Aspects

According to the cognitive psychology literature, long-term memory consists of three key elements: Memories of task process (behavior), memories of semantics (meaning or value), and (most important in this paper) memories of context (environmental associations).^{5,6}

It is asserted that remembered context affects recalled semantics (meaning or value) significantly. This influence is represented in Figure 1 by the vertical arrows linking context and semantics segments. Context also affects recall of necessary task process (behavior). However, since semantics generally are subjective and task processes are more easily measured against "reality", the influence of stored context upon remembered behavior is less than its impact upon semantics. (In checks of existing long-term memory against external reality, it is likely that the task process required currently will have more influence than a remembered task process. By contrast, external semantics will be more influenced by internal representations, as internal and external meet via perceptual filters.)

External Aspects

The external half of Figure 1 is the territory of CAI package developers and instructional designers. Representational semantics (intended meaning) and programmed task process (behavior) are considered fixed stimuli only in the current state of the art. The elements labeled as variable stimuli on the external half of Figure 1 are the primary challenge in contextual e-learning. The key argument of this paper is that technology underlying the fixed stimuli can and should be localized to suit the concerns embodied in elements labeled as variable stimuli here.⁷ This would improve the “cognitive fit” between mental models intended by CAI developers and those needed and expected by e-learners (Day, 1995).

A programmed task process is a behavioral step an e-learner must take in using the CAI package, such as selecting a tutorial to read, linking to an animation illustrating a concept, or indicating he or she is ready for examination. The representational semantics are the multimedia elements used in the package to convey intended meaning to e-learners.⁸ These may vary from simple visual display elements such as text and icons to more exotic multimedia such as force display feedback (Minsky et al, 1992) and time-varying multimedia (Muller et al, 1992).⁹

Each of the three types of context labeled as variable stimuli in Figure 1 is important to the ability of an e-learner to understand and correctly encode material being communicated by the fixed stimuli. As noted earlier, if the context presumed by CAI package developers is significantly different from that expected by an e-learner, increased cognitive load and inaccurate memory (memory without ecological, external validity) can result. However, to date few software products make more than a cursory attempt to address these context concerns.¹⁰

Defining Context. Technology approaches to culture draw heavily upon the work of the Dutch socio-economist Geert Hofstede (Hofstede, 1991), in addition to that of Fons Trompenaars (Trompenaars, 1993) and Edward Hall (Hall, 1959). Hofstede’s “Dimensions of Culture” are used widely in the localization literature. They include:

- **Power Distance:** The extent to which people feel comfortable with large versus small distances between themselves and others who are perceived to have different status within society (sometimes interpreted as a sensitivity toward relative levels of authority);
- **Individualism versus Collectivism:** The orientation toward individual versus group achievements (sometimes described as varying levels of field dependence);
- **Masculinity versus Feminism:** The degree to which a culture favors roles promoting social values of the home and of cooperation, versus work-life concerns related to decision authority and independence;¹¹
- **Uncertainty Avoidance:** The degree to which people are uncomfortable with

uncertainty (sometimes interpreted as the extent to which individuals accept technology characterized by high versus low constraints upon user behavior), and

- ***Long-term Time Orientation:*** The orientation toward Confucian thought, which emphasizes patience (sometimes interpreted as the extent to which a sense of past, present and future affects behavior and perceptions).¹²

Three types of cultural context come into play when an e-learner uses a CAI package developed in another (host) culture: ethnic, group and personal. Power Distance, Uncertainty Avoidance and Long-term Time Orientation are examples of what is meant in Figure 1 by “ethnic cultural context” -- aspects that apply to society at large. Individualism versus Collectivism is “group cultural context”. In some respects, Masculinity versus Feminism is “personal cultural context”, though it also can be considered ethnic.

Implications for Practice

Each of the three variable stimuli in Figure 1 forms part of the context associated with information as e-learners use CAI packages. Taking these contexts into account is especially difficult for CAI developers, since these stimuli are different in every culture where an e-learner may use the software. Certainly, the variable stimuli are different in e-learners’ environments than in the environment where the software was developed. But, it is that “host” culture context that will be communicated by the CAI package, unless an effort is made to localize the product for intended users.

Since personal cultural context is based upon individual differences, it’s not feasible to address it in localization (except by the use of adaptable or adaptive interfaces, which may be engineered to vary somewhat for each user (Day, 1997)). However, it is possible to localize CAI packages for major cultures in terms of ethnic and group context.¹³

Implications of Hofstede’s Dimensions of Culture

Earlier in this paper, we relied upon cognitive encoding theory to explain why cultural context is so important to effective e-learning retention. The implications of this for practice can be introduced handily by a statement from e-Learning Magazine:

A critical aspect of e-learning implementation is that the learner remains very much in their [sic] own culture when engaged in the learning, with local cultural cues in full force around them.

(van Dam & Rogers (2002))

Even though this is true, effective contextualization is easier said than done. In practice, a reading of Hofstede's Dimensions of Culture may imply the following avenues for e-learning implementation - avenues that are certain to add complexity to the engineering of web-based CAI packages. (Examples, other than that for time orientation, are drawn in part from van Dam & Rogers (2002)).¹⁴

Power Distance. In high status cultures, e-learners may be more comfortable with a large difference in authority between them and those presenting teaching material. In a relatively low status culture, e-learners may feel themselves on an equal footing with presenters, implying a feeling of knowledge being shared by all. This may not be the case in high status cultures, where e-learners may expect the presenter to be an expert, teaching the unknowing what needs to be known.

Individualism versus Collectivism. In highly collectivist cultures, people may be more comfortable perceiving that they are part of a group that offers norms and promotes consistency. Success of the group is paramount. However, in individualistic cultures, e-learners may prefer to be in command of the software, moving among modules in a sequence that they prefer rather than being forced into a sequence favored by CAI developers.

Masculinity versus Feminism. (This dimension sometimes is cast as a life-focus aspect of culture.) In masculinity oriented cultures, e-learners may feel it is their duty to undertake CAI outside of work hours, if necessary, to maintain or improve skills. On the other hand, in a feminism oriented culture, e-learners may expect to use CAI packages in the workplace rather than "intruding" upon off hours, family time.

Uncertainty Avoidance. In high uncertainty avoidance cultures, formal rules are preferred and e-learners may not want to risk ambiguity in what is expected of them or how to demonstrate their learning progress. Those in low uncertainty avoidance cultures are more likely to be risk-takers, preferring the "freedom to fail" rather than process guidance constraints.

Long-term Time Orientation. E-learners in a culture with a short time orientation may prefer fast-paced, highly modular CAI packages that allow them to stop at many points, planning to return at a later time. Those with a longer time orientation may be more willing to deal with long, relatively sequential e-learning processes that require a significant amount to be accomplished in each session.

Concerns Regarding Content and Behavior versus Engineering

The implications of cultural sensitivity for e-learning practice divide between content and behavior on one hand, and engineering concerns on the other. Of the two, content and behavior is a more intractable problem because it requires detailed knowledge of appropriate contexts in a large number of cultures. Although the engineering challenge (how to build CAI packages that better match cultural contexts expected by e-learners) is not trivial, several technological solutions hold promise.

Content and Behavior. Researchers such as Geert Hofstede have only begun to

scratch the surface in establishing and validating a taxonomy of cultural context. Although implications can be drawn from the Dimensions of Culture (and similar schemes), it remains to be seen how reliably specific cultures can be assigned to each dimension. Also, there is no certain mapping of specific product design elements and behaviors to the various cultural taxonomy schemes. Inferences may be drawn, but they remain to be validated by results. This connection between theory and practice is much discussed at events such as IWIPS (<http://www.iwips.org>) and CATaC (<http://www.it.murdoch.edu.au/~sudweeks/catac02/>). However, the lack of rigor in validating this linkage between theory and practice has not prevented firms (e.g., members of the Localization Industry Standards Association (<http://www.lisa.org/>)) from attempting ad hoc, case-by-case localizations of products and systems.

Content and behavior concerns also might be addressed by adapting lessons learned in other electronic, distance interaction domains. For example, a couple of papers presented at the annual internationalization workshop (IWIPS) have addressed e-finance content and behavior (Smith, French, Chang & McNeill (2001); French, Minoch & Smith (2002)). Although many of the dynamics of e-finance sites vary from those of web-based CAI packages, the 2002 paper (for example) makes it clear that there are e-finance lessons of importance to e-learning developers: "Our aim is to forewarn organizations considering entering these markets to the importance of culturally matching web-site content to the intended local audience..."

In fact, the localization literature includes work directly related to CAI (e.g., Bourges-Waldegg, Moreno & Rojano (1999), who compare differences in teaching-learning approaches between the UK and Mexico). Krock (1996) discusses issues such as the acceptance of foreign instructors, differences in student-teacher interaction, the pace and intensity of training, technology literacy, and English fluency.

Engineering. The object-oriented software design and development model and related software engineering methods such as the Rational Unified Process (RUP) make it possible to modularize e-learning applications and to decrease dependencies among software elements.¹⁵ The practical benefit is that just as with a camera that has a removable film pack, CAI packages intended for cross-cultural distribution can include a common core of basic functionality while still making available localized versions of key interface and even behavioral components. With or without object-oriented techniques, use of a highly iterative software engineering model adapted for localization can ease the task of developing customized versions of packages (Livermore & Coronado (2001)).

In recent years, several firms have entered the localization and e-learning markets, creating packages for cross-cultural use. For example, IBM has a development product called "Mindspan"; Mentergy has implemented e-learning in remote districts of Brazil,¹⁶ and Johnston & Associates (<http://www.jaglobal.com/>) performs localization on a variety of products.

IBM's approach to context issues in Europe is to support individual e-learning

customization teams for France, the UK, Germany, Spain and Italy, with a network of developers for the Nordic countries.¹⁷ However, this fragmented approach is not favored by the internationalization community, whose members cite the expense of labor-intensive development and the configuration control risks of multiple versions of the same package (even if a common code base is used). Instead, more complex but in the end less costly engineering is favored, such as use of templates, resource files or message catalogs containing culturally specific elements, metadata tags, and dynamic content (e.g., active server pages). Unfortunately, of the engineering tools available currently, only workflow (navigation) management addresses the most difficult context relevance issue: product behavior expected by users.

Conclusion

This paper has argued that a tight cognitive coupling exists between context and learning. It has made the case that when learners encounter CAI packages built with unfamiliar cultural contexts, their cognitive load increases and the accuracy of retained information declines. A Contextual Encoding Linkage Model including various cultural contexts was offered to illustrate these effects.

The paper also introduced Dimensions of Culture theory (from the internationalization literature), as a means to address the content and behavior concerns at the root of the cultural context issue, and provided examples of its implications for practice.

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Footnotes

1. The literature in computer-mediated communication suggests that computerized tools (e.g., CAI packages) communicate favored “world views” (including cultural perceptions of appropriate understanding and behavior) *between* developers and users. (Day & Kovacs, 1996, p.vii.) The sharing of world views *among* users is discussed in Mandviwalla (1996).
2. For example, different behaviors (task processes) are appropriate when welcoming guests into one’s home, in Japanese, American, and South African cultures.
3. This language specific example is offered as especially appropriate to the symposium’s theme of “E-learning beyond Cultural and Linguistic Barriers”.
4. For examples of intercultural communication approaches and concerns, see Samovar & Porter (1991)—especially Chapter 4, “Cultural Contexts: The Influence of Setting”.
5. The terms used here for encoded long term memory are somewhat different from those in the cognitive psychology literature. There, “procedural” sometimes is used for “task process” (here) and “episodic” is used for “context” (here).
6. “Task Process” is what is referred to as “rules, formulas, and algorithms” in the Tulving definition of semantic memory presented earlier in this paper.
7. Use of the term “should” here is justified not only by my interpretation of e-learner needs, but also in the spirit of the symposium theme - which supports e-learning co-existence and collaboration.
8. The appropriate granularity of meaning (literal versus conceptual) one should intend to communicate to various potential e-learner groups is beyond the scope of this paper. However, those interested may consult Roschelle, 1996.
9. “Force display” refers to use of the haptic (sense of touch) system, typically via joystick feedback; time-varying media include real-time voice and streaming video.
10. A dated but still valid example of cultural problems in software is included in the early localization book by Tony Fernandes (1995). A package intended for Japanese children uses an illustration showing a school bus with left-hand drive and a Western-style postal pick-up box (neither is the correct style in the target culture).
11. Hofstede did not mean for this dimension to address stereotypical, gender-based roles, but rather the societal views characteristic of those roles in the Western societies where he conducted his research.
12. Thanks to Aaron Marcus (Marcus, 2002) for the base version of this list, whose annotations have been edited by the author of this paper.
13. For an extended review of the literature in software localization, see Carey (1998).
14. See Hofstede (1991) for characterizations of where specific cultures are thought

to fall on each of the five dimensions.

15. See <http://www.rational.com/media/products/rup/TP164.pdf> for a discussion of how RUP can be applied to web content management (a major concern of variable, cross-cultural implementations in e-learning). (Last accessed 18 September 2002.)
16. See <http://www.mentergy.com/about/press/pr.cfm?ID=18>. (Last accessed 18 September 2002.)
17. See [http://www-3.ibm.com/software/mindspan/distlrng.nsf/89297bbbe911d2788525674c00675635/92a156340bae97cc85256a4e0033c614/\\$FILE/Directions%20in%20e-Learning.PDF](http://www-3.ibm.com/software/mindspan/distlrng.nsf/89297bbbe911d2788525674c00675635/92a156340bae97cc85256a4e0033c614/$FILE/Directions%20in%20e-Learning.PDF).
(Last accessed 18 September 2002)