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A Taxonomy of Learning Technologies: Simplifying Online Learning for Learners, Professors, and Designers

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ABSTRACT

At many Universities and colleges a range of learning technologies is used in an approach to learning that blends face-to-face and online methods. Often those who design blended courses need tools to guide their decisions of which technology to match to learning activities. The Taxonomy of Learning Technologies was developed to assist designers make appropriate use of learning technologies by classifying them within a simple taxonomic system. The intention was to produce a taxonomy that is sufficiently robust for general application and simple enough to be accessible to busy academics.

INTRODUCTION: WHAT IS A TAXONOMY?

There are many definitions of taxonomy and most of them refer to systems for the classification and organization of living things. Carl Linnaeus developed the most well known taxonomy during the expansion of natural history knowledge in the eighteenth century. It is the scientific system for the classification of living things and has the basic structure of: organism, domain, kingdom, phylum, class, order, family, genus and species.

The Linnaean Taxonomy is a deep hierarchical structure which is to be expected given the number and diversity of living things. It is reasonable to expect that a taxonomic system for learning technologies would be smaller due the smaller number of items.

It has been argued (Wikipedia 2005) that the human mind uses organizational structures to naturally and systematically order information received and hence make sense of the world. A taxonomy can then be an appropriate tool that informs the matching of technologies to learning activities. In this paper a new organizational structure, or Taxonomy of Learning Technologies is presented. the Taxonomy of Learning Technologies divides learning technologies into broad categories depending on the communications channels. That is: one-way or two-way>

There have been other attempts to classify or organize learning technologies and while their classification frameworks are logically sound they are less readily applicable to the task of matching appropriate learning technologies to learning activities by teacher/designers.

Many of the approaches are designed for large distance education institutions which have large instructional design resources (Laurillard 2002). The taxonomy presented here is designed for smaller institutions where the teacher is the designer and hence selects the technology.

One approach by an organization with instructional design resources (Sun Associates 2001) is to divide technologies into the categories:

- Tutorial technologies
- Application uses of technologies
- Exploratory technologies, and
- Communications technologies.

This approach is helpful but it does not provide an insight to the nature of the technology rather than suggesting how the technologies should be used. For example under communications technologies no differentiation is made between videoconference, which is two-way and Web searching which is one-way.

Another approach (Bruce and Levin 1997) divides the technologies into the categories:

- Media for Inquiry
- Media for communication
- Media for construction, and
- Media for expression.

Bruce and Levin's taxonomy further subcategorizes technologies and while theoretically helpful, could confuse as the basic differentiation between one-way and two-way is not apparent. They include document preparation as a sub category of media for communication. It can be argued that all education is communicative and this category does not help to tease apart the different appropriate uses of the technologies.

WHY HAVE A TAXONOMY?

The Taxonomy of Learning Technologies presented here has been developed to assist users of learning technologies efficiently gain an appreciation of the basic nature of learning technologies and hence apply them appropriately. This should then lead to uses of learning technologies that promote effective and efficient learning.

In many universities and colleges the teaching model is a blend of face-to-face and technology mediated methods. Professors are usually experts in their own fields and when their field is not education they can find the tasks of designing and implementing learning events that have both face-to-face and technological components challenging. A significant amount of anecdotal evidence suggests that the process of design and implementation could benefit from an efficient guide to the appropriate application of technology.

At many institutions, the technologies of blended learning courses can be enclosed in a Learning Management System (LMS) or located outside of it. For example lecture notes and slides can often be found within the LMS but videoconference is generally located outside of the LMS and the boundaries of the LMS are blurred as new features and technologies are added with each new version. The range of technologies and the lack of time for intensive staff development can lead to misuses of technologies. A characteristic example is the misuse of the two-way technology: videoconference. When used in a two-way or dialogic fashion videoconference can be an effective learning technology. However, if a one-way or presentational style is used in a videoconference, the result can be ineffectual. This misuse is often hinted at when professors complain that students go to sleep in their videoconferences.

Taxonomies are not new in the field of education. Almost fifty years ago a widely-used taxonomy of educational objectives was published

(Bloom et al 1956). Commonly referred to as Bloom's taxonomy it was concerned with types of knowledge. This taxonomy has been revised (Anderson et al 2001) and is still in use today. However, Bloom's taxonomy does not consider the technological methods through which the learning objectives are attained in a blended learning environment.

THE TAXONOMY OF LEARNING TECHNOLOGIES

The theoretical basis for the Taxonomy of Learning Technologies is provided, in part, by researchers in the field of Distance Education through their description of learning technologies as one-way or two-way (Bates 1995, Rowntree1992). Writing in the area of Open and Distance Learning, Bates distinguishes between one-way and two-way technologies by stating that two-way technologies are those that support communications between humans. This was an inclusive description of learning technologies in the 1970s. While learning technologies can still be adequately described as one or two-way they have evolved greater functionality and new technologies with special applications for learning have arrived. These developments in learning technologies require an expansion of their description beyond simply one-way or two-way.

The research on which the Taxonomy of Learning Technologies is based takes this rather basic conceptual approach, redefines it and juxtaposes it with theories developed for technology selection in the field of Organizational Communications to produce a taxonomy or framework for the analysis and categorization of learning technologies. As well the taxonomy includes some newer learning technologies that while they support communications between humans they are also intended to be used by the collaborators to create products.

As with different methods of communication, different teaching techniques, methods and technologies support or require different communication cues or attributes. For example, a discussion where learners are gathered at the same time and in the same place can consist of a dialog in which several levels of attributes can be present. Learners hear the text of the speech. They also hear the emphasis, pace, volume, pitch, and inflection and other vocal attributes of the speech. Also, they see the body language and other non-verbal communications of the speakers. As well learners may have the opportunity to question the speaker and hopefully achieve the desired goals of the learning event. In a second example where material is provided by a textbook, learners read the text and view the diagrams in it. While, the vocal and non-verbal attributes of the first example are not available, the learner has the option to find their own way through the book. They can elect to read from beginning to end or to repeat or dwell on salient sections and skim through others. They can refer to the index and other access devices in the book.

Theories for the selection of technologies in the field of Organizational Communications include two early trait theories that developed scales of richness or ability to facilitate social presence. The Media Richness Theory (Daft and Lengel 1984) and The Social Presence Theory (Carlson and Davis 1998) both describe technologies as having degrees of richness based on:

- The number of communication cues available,
- The ability to provide feedback,
- Personalization, and other factors.

For example both theories determine that face-to-face communication is richer than telephone, which in turn is richer than a written letter or memo.

Later research (Carlson and Davis 1998, Guthrie 2000) has indicated that the choice of technology is more complex, and has been made so by other factors such as the introduction of Information and Communication Technologies late last century as these technologies often have other attributes that impact on their choice.

While it is recognized that the trait theories fall short of providing an inclusive description of the factors that impact on the selection of technologies, they do provide a convenient hierarchy within which an analysis of technologies can be undertaken. The hierarchy is adopted as part of the taxonomic structure as it allows the differentiation of technologies based on communicative cues, or attributes.

LEARNING TECHNOLOGIES.

Compared to face-to-face learning, when learning technologies are used to provide, facilitate or mediate learning activities, they can impose restrictions on the communication cues available. For example, if a discussion is mediated by an audio-conference, participants at one site cannot see those at other sites and hence the non-verbal attributes of the dialogue of speakers at the other sites are not available. Further, if the discussion was mediated by email or Internet Chat, the only available attribute of the dialogue would be text.

There are too many variables for it to be argued that fewer available communication cues or attributes in a learning technology will always equate to a reduction in the quality of learning experience. In some cases a reduction in the set of attributes or communication cues can enhance the learning experience through the provision of a narrower focus. In other cases there may be "trade-offs" that are worthwhile. For example, if learners elect to study at times and places that suit themselves they may be limited to interacting with other learners and the facilitator by asynchronous and communicatively limited means such as email. For them the "trade-off" is a reduction in the attributes or communication cues in favor of a flexible learning program.

Based on research in the area of open and Distance Learning (Bates 1995, Rowntree 1992), in the top layer of the taxonomy, learning technologies are categorized as one-way or two-way. More descriptive titles have been chosen and the one-way learning technologies are labeled as "Representational" as they represent things or materials. The two-way labeled as "Collaborative" as they facilitate collaborations. There are examples of learning technologies that perform in both categories, although usually their performance in one category is more effective and/or more efficient than in the other.

REPRESENTATIONAL LEARNING TECHNOLOGIES.

The term "Representational" is used here to describe the nature of the communication in the one-way representation or provision of material. Different Representational technologies have different capabilities or attributes of representation. For example, while printed materials can only represent material as text and still images (and in many cases as text alone), video can represent material with full motion pictures and audio. The available attributes of Representational learning technologies can be broadly categorized as:

- Text only,
- Audio only,
- Text and still images,
- Audio and still images, and
- Audio and moving images.

Representational technologies can then be further categorized in the taxonomy by the available attributes.

COLLABORATIVE LEARNING TECHNOLOGIES

Similarly to the first category, different Collaborative technologies support different attributes. For example, while telephones support dialog in which the words, or text, of each speaker contributes to the interaction they also support vocal characteristics such as timbre, inflection, emphasis, pitch, pace, tone and volume. Collaborative technologies can then be further categorized in the taxonomy by the available attributes. The attributes can be broadly grouped as:

- Text only
- Voice only, and
- Voice and non-verbal attributes

Table 1. Attributes of representational and collaborative learning technologies

Communication Cues or Attributes	Representational	Collaborative
Level 1	**Text only** Text and still images - eg: printed material	**Text only** - eg: email
Level 2	**Voice** and other audio sound effects found sound music and other sounds - eg: radio broadcast, audio tape	**Voice only** - eg: telephone - compressed hence vocal attributes may be less apparent.
Level 3	**Voice and moving pictures** Plus other audio Plus non-verbal when presenter on screen and close. - eg movie or video tape	**Voice and image (face to face)** Plus non-verbal Plus other audio Plus other images still or moving - eg video-conference

In the above list, voice could be construed as text plus the vocal attributes and the non-verbal attributes refer to eye contact, body language, etc. Hence voice plus non-verbal attributes can be construed as text plus vocal attributes plus non-verbal attributes.

As existing technologies develop and new technologies are created it is reasonable to expect that a taxonomy that describes them must expand and change to remain germane. Recent additions to learning technologies include tools that allow students to collaboratively create products in online environments. For example Wiki's (http://wikimediafoundation.org/wiki/Home), CUPIDs (Collaborative, User-Produced Internet Documents) (Caladine 2005) can be used to create products such as group reports or create glossaries online. Shared eWhiteboards and application sharing are further examples of collaborative learning technologies that support two-way communications and facilitate the creation of products. Therefore the subcategories of the Collaborative Technologies category are termed "Dialogic" and "Productive". Dialogic learning technologies are defined as those that are confined to the support of dialogue alone: for example telephone. Productive learning technologies combine two-way communications and facilitate the creation of products.

The attributes of learning technologies can be generalized and grouped into three levels of communications cues and used as further subcategories of the taxonomy.

There are other characteristics of learning technologies that impact on learning and hence need to be considered in the taxonomy in order to describe the technologies more fully. One of these characteristics is whether the technology supports synchronous or asynchronous interactions.

SYNCHRONOUS OR ASYNCHRONOUS LEARNING TECHNOLOGIES

Learning technologies can be described as either synchronous or asynchronous. Synchronous interactions are those that happen more or less at the same time. Asynchronous ones do not. For example, videoconferences are described as synchronous, meaning that learners and facilitators participate in the conference at the same time. Email and Internet Chat provide a good example of the difference between synchronous and asynchronous technologies. Email is usually responded to at the discretion of the user and hence is described as asynchronous. However, when in a Chat session each participant knows that the others are waiting for their responses. The resulting "conversations" are synchronous, develop at their own pace, are quite different from email interactions and hence can be used to serve different learning purposes.

In the early days of the Internet, and as its use for learning increased, the debate over the benefits of asynchronous versus synchronous communication gained momentum as the Internet provided efficient and available applications for both synchronous and asynchronous communications. Some proponents suggested that asynchronous communication was, by its very nature, of a higher quality (in both learning and communications senses) as learners had time to consider their responses. Others maintained that the spontaneity learners were used to with face-to-face communication was all-important. It is argued here that both types of communications have roles to play in learning. Asynchronous communications certainly provide opportunities for learners to meet learning objectives that require them to consider their responses, while synchronous communications can help learners develop skills such as "thinking on their feet". Both forms of communication have valid and different uses in learning and surely the best use of a learning technology occurs when it is selected to meet a synchronous or asynchronous learning need.

A TAXONOMY OF LEARNING TECHNOLOGIES

The Taxonomy of Learning Technologies categorizes technologies as Representational or Collaborative. Collaborative technologies are then divided into the sub-categories of "Dialogic" or "Productive". Within each of these categories individual technologies can be further described by their synchronicity or asynchronicity.

When technologies are described by the taxonomy their appropriate use is signified in general terms by their classification. A videoconference is classified as Collaborative, Dialogic and synchronous which clearly indicates that it is intended to host a synchronous collaborative dialog. This contrasts with a Webcast which is classified as a representation synchronous technology indicating that it is a synchronous, one-way technology which can be used effectively for the representation of material. Other examples are shown in Table 2.

When the levels of attributes are added to the taxonomy a more detailed description of learning technologies is available. For example a radio broadcast of a lecture or documentary would be classified as Representational, synchronous (unless recorded for later use – when it would be asynchronous) and have level 2 attributes. This compares to a television broadcast of a similar nature that would have the same classification except that the attributes would be level 3. The complete taxonomy as shown in Figure 2, lists a total of 18 possible categories of learning technologies. At the time of writing it is not possible to find examples for all categories. However all categories are included so that the taxonomy is a framework that can adapt in some measure to future technologies.

The Taxonomy of Learning Technologies provides a description of the basic nature and characteristics of learning technologies, which is a first step in the facilitation appropriate application of the technologies.

CONCLUSION

The Taxonomy of Learning Technologies takes the basic division of technologies into one-way and two-way (Bates 1995, Rowntree,1992), renames it and adds subcategories to create an organizational structure that is sufficiently robust for general application to technologies used in learning and simple enough to be accessible to busy academics. The

Figure 1. Basic structure of the taxonomy of learning technologies

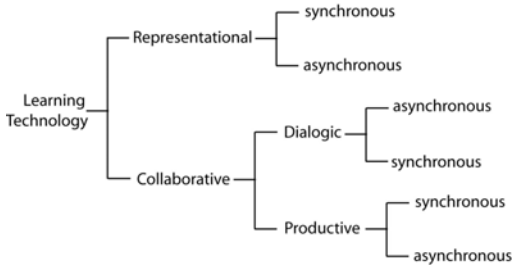


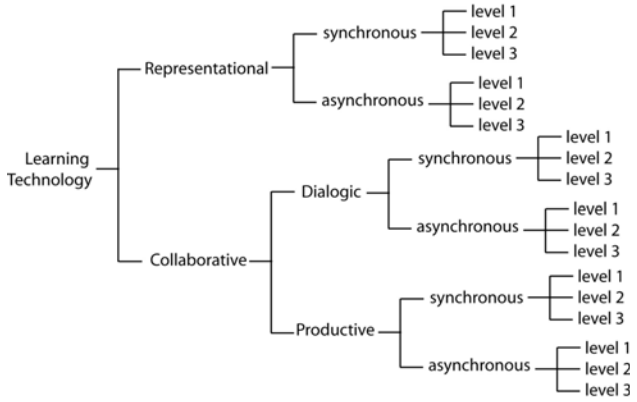
Table 2. Examples of learning technologies as classified by the taxonomy of learning technologies

		Examples	level
Representational	synchronous	Webcast	2 or 3
		Live radio broadcast	2
		Live TV broadcast	3
	asynchronous	Streamed recording	2 or 3
		Web pages	1
		Downloadable documents	1
		Downloadable presentations	1
		Podcasts	2
		Vodcasts	3
		Multimedia	3
Dialogic	synchronous	Videoconference	3
		Audio-conference	2
		Telephone	2
		Instant messaging/Chat	1
	asynchronous	Discussion forum	1
		Email	1
Productive	synchronous	Shared eWhiteboard	2
		Shared applications	2
		Shared Desktop	2
		Audio graphics	2
	asynchronous	Wikis	2
		Blogs (text)	1
		CUPIDs	2

taxonomy is designed to provide designers of blended learning courses an introduction to the appropriate uses of learning technologies.

The Taxonomy of Learning Technologies was developed to describe the learning technologies available at the time of writing. It is difficult to predict the near future and impossible to predict the distant future in the field of learning technology. It is hoped that if the taxonomy does not describe future technologies, it will be able to be easily changed to do so.

Figure 2. Taxonomy of learning technologies



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