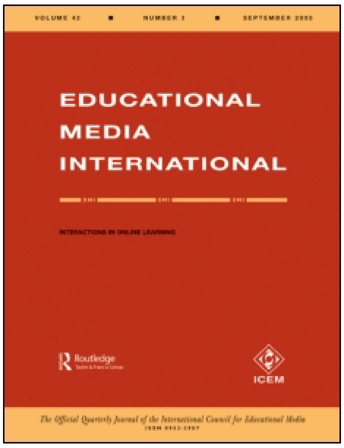

Educational Media International
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713698864

Affordance analysis - matching learning tasks with learning technologies

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Online Publication Date: 01 March 2008

Educational Media International
Vol. 45, No. 1, March 2008, 3–15

Affordance analysis – matching learning tasks with learning technologies

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(*Received 16 July 2007; final version received 26 November 2007*)

This article presents a design methodology for matching learning tasks with learning technologies. First a working definition of "affordances" is provided based on the need to describe the action potentials of the technologies (utility). Categories of affordances are then proposed to provide a framework for analysis. Following this, a methodology for designing e-learning experiences by matching the affordance requirements of tasks with the affordances offered by the available technologies is described. Rather than being prescriptive, the methodology is designed to be adjustable, expandable, and applied to various degrees of rigor depending on the context. An example application of the methodology is provided for illustrative purposes.

Une analyse des capacités – Faire correspondre les tâches d'apprentissage avec les technologies d'apprentissage
Cet article présente une méthodologie de conception permettant la mise en phase des tâches d'apprentissage avec les technologies d'apprentissage. On fournit tout d'abord une définition opérationnelle des « capacités », définition fondée sur la nécessité de décrire le potentiel actif des technologies (utilité). On propose ensuite des catégories de capacités afin d'offrir un cadre d'analyse. A la suite on présente une méthodologie d'élaboration des expériences de e-learning en faisant correspondre les besoins en capacités de chaque tâche avec les capacités offertes par chaque technologie. Cette méthodologie n'est pas prescriptive mais elle est plutôt conçue pour être modifiable, extensible et appliquée aux divers degrés de rigueur en fonction du contexte. A titre d'illustration, on fournit un exemple d'application de cette méthodologie.

Affordanz-Analyse – die richtige Lerntechnologie passend zur Lernaufgabe
In diesem Artikel wird eine Entwurfsmethode vorgestellt, um Lerntechnologien passend zur Lernaufgabe auszuwählen. Zunächst wird eine Arbeitsdefinition von "Affordanz" (Nutzungsangebot einer Technologie) vorgestellt, die vom Bedarf einer Beschreibung von Aktionspotenzialen der Technologien ausgeht (Nützlichkeit). Kategorien von Affordanz werden dann vorgeschlagen, um einen Rahmen für die Analyse zu liefern. Dieser Richtung folgend wird eine Methodologie zur Gestaltung von Erfahrungen beim e-Learning vorgeschlagen, die zur Übereinstimmung der Anforderungen an die Affordanz von Aufgaben mit der Affordanz angebotener Technologien führen. Diese Methodologie ist nicht präskriptiv, sondern anpassungsfähig und ausdehnbar, außerdem anwendbar auf verschiedene Starrheitsgrade in Abhängigkeit vom Kontext. Eine Beispielanwendung soll diese Methodologie illustrieren.

Un análisis de capacidades – La sintonización de las tareas de aprendizaje con las tecnologías de aprendizaje
El presente artículo presenta una metodología de diseño para sintonizar las tareas de aprendizaje con las tecnologías de aprendizaje. En primero lugar se facilita una definición operacional de las « capacidades » basada en la necesidad de ofrecer una descripción de los potenciales operacionales de las tecnologías (utilidad). En segundo lugar presentamos algunas

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ISSN 0952-3987 print/ISSN 1469-5790 online

DOI: 10.1080/09523980701847115
http://www.informaworld.com

categorias de capacidades para armar un marco de análisis. A continuación se describe una metodología para diseñar experiencias de e-learning basada en la sintonización de las capacidades que requieren las diversas tareas con las capacidades propias de las tecnologías disponibles. En su diseño, esa metodología no es prescriptiva sino más bien adaptable, expandible y aplicable a diversos grados de rigor en función del contexto. Para ilustrar eso se facilita un ejemplo de aplicación.

Keywords: affordances; e-learning design; instructional design

Introduction

Throughout the educational design literature there have been several attempts to support the selection of appropriate delivery modes, including those that focus upon media, those that consider the higher level educational processes that are facilitated, and those that concentrate on more general sociological and pragmatic issues at an institutional level. Reiser and Gagné (1982) describe how several models developed in the 1970s and 1980s use the physical attributes of the media (such as visual, printed words, sound and motion) to make media selection decisions for learning tasks. They note, however, that these models often remove the rationale for media selection from the educational designer. By providing a prescription for selecting a single 'correct' media choice rather than scaffolding the media selection decision-making process, the expertise of the learning designer is devalued (Reiser & Gagné, 1982, p. 505). As well, these models focused on the selection of media, whereas contemporary educational design needs to focus on the selection of technologies which are complex combinations of media that do not fall into simple categories.

Rubens, Emans, Leinonen, Skarmeta, and Simons (2005) propose a framework for designing technology-based learning frameworks that "scaffold progressive inquiry", provide tools for "structuring and coordinating activity", and "support community building". These are unquestionably important characteristics for a learning environment to possess; however, they are defined at a level above the attributes of the technologies. An environment can use the properties of technologies to construct tools that accomplish these aims, and evaluations should occur at this higher level; however, such features of a learning environment are complex manifestations of more primary technological facilities.

Other researchers adopt a more feedback-driven, practical approach to support educational technology selection and evaluation. Margolis, Nussbaum, Rodriguez, and Rosas (2006) consider factors such as "student rating", "cost", and so on to gauge the efficacy of technological tools. Their coarse grain, pragmatic and partially socially mediated evaluation process serves a useful purpose in the selection of technology, but is not appropriate for understanding how tools interplay with cognition and hence how to best design educational systems that meet the learning requirements of tasks.

This article describes a methodology to support the technology selection process by demonstrating how an explicit approach to identifying technological affordances of e-learning tools and the affordance requirements of e-learning tasks can be used to scaffold the learning design process. A methodology rather than a prescription is being proposed, allowing control for the design process to be retained by educators rather than subsumed by a mechanical process.

First, the meaning of affordance is clarified by selecting a particular definition amongst the various applications of the term from within the literature. After this, categories of technological affordances are proposed, based partly on previous work in categorizing affordances but more so from reflecting upon the properties of e-learning tools and how users interact with them. On this basis a methodology for matching learning tasks with e-learning technologies is described. An example in practice is provided for illustrative purposes.

Affordances

"Affordance" has become a popular term in educational circles, but also one that has been used with several different meanings (Hartson, 2003; McGrenere & Ho, 2000). Gibson (1979) first coined the term "affordance":

> The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill. The verb *to afford* is found in the dictionary, but the noun *affordance* is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment. (p. 127, italics in original)

In the original description that Gibson provides, an "affordance" is present as long as the organism is physically able to undertake the required action, and as long as the possibility of executing that action is present. For instance, a postbox is a "letter-mailing-with-able" object with relation to a physically able adult, whether or not it is perceived as such. To Gibson "an affordance is not bestowed upon an object by a need of an observer and his act of perceiving it" (1979, p. 139).

The other frequently cited proponent amongst the affordance literature is Donald Norman, who describes an affordance as a design aspect of an object which suggests how the object should be used:

> The term *affordance* refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords ('is for') support and, therefore, affords sitting. A chair can also be carried. (Norman, 1988, p. 9)

Norman emphasizes the idea of "perceived" affordances – that until an affordance is perceived it is of no utility to the potential user. Thus according to Norman (1988), real affordances are not nearly as important as perceived affordances. It is perceived affordances that determine the actions that can be performed and signal to the user how they may be accomplished.

The distinction between Gibson's and Norman's definition of affordances is important, because it determines whether or not the term "affordance" encompasses usability or just utility (Kirschner, Strijbos, Kreijns, & Beers, 2004). Gibson's frame of reference focuses upon the fundamental characteristics of the object in relation to the user, which is a question of utility. Norman places more emphasis on how an object is perceived, which relates to usability and not just utility.

In this article Gibson's original definition of affordance will be used so as to make the clear distinction between usefulness and usability. The current interest is in discriminating how technologies can be applied to design learning tasks, not to evaluating them, so the underlying properties are the focal point. Separating the inherent properties of the objects and how they are perceived also avoids any contextual biases that could be caused by the experience or culture of the user. As McGrenere and Ho (2000) point out, designing the affordance should not be confounded with designing the information that specifies the affordance. Note that in later works Norman himself revises his original definition in order to distinguish between "real" and "perceived" affordances (Norman, 1999).

Classifying affordances

Some authors have made attempts to broadly classify affordances, which inform the categorization proposed herein. Scarantino (2003) categorizes affordances as being either mental, basic physical, and non-basic physical, while Hartson (2003) untangles previous ambiguities associated with the concept of affordance by distinguishing between cognitive affordances, physical affordances, sensory affordances and functional affordances. In this article an effort has been made to describe affordances based on their physical characteristics, emphasizing their functionality (in accordance with Gibson, 1979) and thus allowing a more fundamental level of analysis to be conducted. Later sections describe how these functional affordances can be applied in combination to meet learning objectives for different types of tasks.

Categories of affordances can be implicitly distilled from discussions of learning technologies that have been presented by other authors. In their analysis of how the affordances of music software can be leveraged to provide new opportunities for students to learn composition, Gall and Breeze (2005) discuss the affordances offered by different modalities within multimodal text (in particular, audio, linguistic, visual, gestural and spatial). In an article considering the effectiveness of network-based communications, Conn (1995) refers to time as a critical affordance of a software application. Such cases provide specific, implementation-level definitions of affordances, and verification for the applicability and usefulness of categories presented in this article.

Another important affordance classification system for the purposes of analyzing how to best match learning tasks to e-learning technologies comes from Kirschner et al. (2004). They present an affordance framework that defines not just technological affordances, but also social affordances and educational affordances as follows:

- Educational affordances: characteristics of an educational resource that indicate if and how a particular learning behavior could possibly be enacted within the context;
- Social affordances: aspects of the online learning environment that provide social-contextual facilitation relevant to the learner's social interaction.

These two dimensions serve to illuminate the major foci when designing learning experiences using technology – the task and the approach to collaboration. The following section proposes a framework for classifying e-learning technology affordances to support the educational and collaborative design of learning tasks.

E-learning technology affordances

The affordance classification system below is presented to provide a vocabulary for subsequent discussion within the article. Terms within the different categories of affordances are defined as abilities, thus emphasizing the action possibilities they offer the user.

(1) ***Media affordances*** – the type of input and output forms, such as text ("read-ability", "write-ability"), images ("view-ability", "draw-ability"), audio ("listen-ability", "speak-ability"), video ("watch-ability", "video-produce-ability").

(2) ***Spatial affordances*** – the ability to resize elements within an interface ("resize-ability"), move and place elements within an interface ("move-ability").

(3) ***Temporal affordances*** – access anytime anywhere (accessibility), ability to be recorded ("record-ability") and played back ("playback-ability"), synchronous versus asynchronous ("synchronicity").

(4) ***Navigation affordances*** – capacity to browse to other sections of a resource and move back/forward ("browse-ability"), capacity to link to other sections within the resource or other resources ("link-ability"), ability to search ("search-ability") and sort and sequence ("data-manipulation-ability").

(5) ***Emphasis affordances*** – capacity to highlight aspects of a resources ("highlight-ability"), explicitly direct attention to particular components ("focus-ability").

(6) ***Synthesis affordances*** – capacity to combined multiple tools together to create a mixed media learning environment ("combine-ability"), the extent to which the functions of tools and the content of resources can be integrated ("integrate-ability").

(7) ***Access-control affordances*** – capacity to allow or deny who can read/edit/upload/download/broadcast/view/administer (“permission-ability”), capacity to support one–one/one–many/many–many contributions and collaborations (“share-ability”).
(8) ***Technical affordances*** – capacity to be used on various platforms with minimal/ubiquitous underlying technologies, ability to adapt to bandwidth of connection, speed & efficiency of tool/s.
(9) ***Usability*** – intuitiveness of tool, ease with which user can manipulate tool to execute its various functions, relates to efficiency.
(10) ***Aesthetics*** – appeal of design, appearance of interface, relates to user satisfaction and ability to hold attention.
(11) ***Reliability*** – robustness of platform, system performs as intended whenever required.

The last four categories are non-functional from an educational point of view in so far as they relate to the quality of the learning experience but not to what can be objectively accomplished in terms of educational design (although aspects such as bandwidth and reliability can of course affect this at a pragmatic level). The effectiveness with which a tool or interface delivers or signifies these last four affordance categories relates to the usability (evaluation) of a system rather than its educational potentials (utility), and as such they are not further considered in the affordance analysis methodology to follow. The construction of an affordance based e-learning system evaluation framework is left as an open matter for further research and investigation.

The functional affordances described above are represented in Table 1. They have been classified by the degree of interaction they enable, either:

- *Static/instructive*: affordances that allow fixed representations and one way transmission of information;
- *Collaborative/productive*: affordances that allow flexible representations that can be adjusted and shared.

Table 1. Functional affordances, categorised by type and degree of interaction.

	Static/instructive		**Collaborative/productive**
Media affordances:	read-ability view-ability listen-ability watch-ability		write-ability draw-ability speak-ability video-produce-ability
Spatial affordances:		resize-ability move-ability	
Temporal affordances:	playback-ability	accessibility	record-ability synchronous-ability
Navigational affordances:	browse-ability search-ability	data-manipulation-ability	link-ability
Emphasis affordances:	highlight-ability		focus-ability
Synthesis affordances:		combine-ability integrate-ability	
Access-control affordances:			permission-ability share-ability

The list of affordances is not meant to be exhaustive, nor is it proposed that the categories are absolute (although every effort has been made to construct a sensible classification system). Rather, the affordance descriptors are meant to offer an example as to the fundamental, pragmatic, and functional level at which affordances should be identified in order to be suitable for matching to the affordance requirements of various learning tasks. The affordances described represent an expandable list in so far as other affordances (and potentially categories) can be added as they are perceived by the designer. The point being emphasized is the process of consciously identifying the affordances of e-learning tools, so that they can then be considered in light of the affordance requirements of the learning tasks. This is represented in the next section as the "affordance analysis e-learning design methodology".

The affordance analysis e-learning design methodology

Figure 1 summarizes the affordance analysis design methodology.

The framework is best explained by way of example (which is provided in the following section), but a brief description is as follows:

(a) *Identify educational goals* – decide the overarching intentions of the learning design;
(b) *Postulate suitable tasks* – based on the experience of the designers, propose general tasks to satisfy the educational goals;
(c) *Determine the affordance requirements of the tasks* – for the general tasks postulated establish the affordances needed to provide the desired representations and interactions;

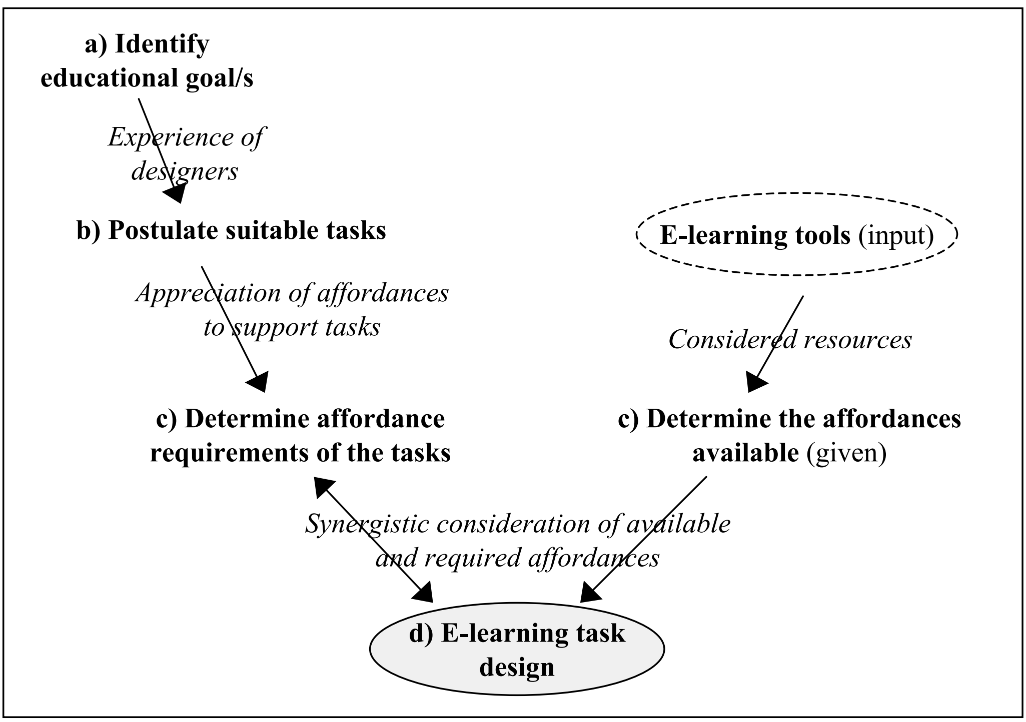

Figure 1. The affordance analysis e-learning design methodology: matching tasks with technologies to construct e-learning designs.

AND

(c) *Determine the affordances available* – based on the technological resources being considered by the designer, establish the sets of affordances that can be deployed (at the same time as performing the previously described step);
(d) *E-learning task design* – synergistically integrate the available and required affordances to form a specific task design (iterative process).

The methodology is not simply a contiguous sequence of stages. Jonassen, Lee, Yang, and Laffey (2005) point out that educational designers should focus on both selecting collaborative technologies that match the pedagogy of the instruction and design instructional practices that take advantage of the technological tools (p. 251). Determining technological affordances before considering tasks can lead to unnecessary analysis. Determining the exact affordance requirements of a task without an appreciation of the affordances availed by the technologies may mean that implementation is impractical. For this reason, simultaneous consideration of task affordance requirements and affordance availabilities is needed.

Another non-linearity is introduced as the design concretizes – based on unforeseen possibilities or limitations, the affordance requirements of the task may need to be revised. This necessitates iteration between the task requirements and final design stages, as indicated by the double arrow in the diagram.

Implicit in the methodology is that it is not possible to directly apply a function that prescribes a learning task based upon the educational affordances of the tools and the pre-identified cognitive components of learning. The learning task could be one of several. However, what is being proposed is that it is possible to use this framework as a guide to thinking about the design of technologically based educational tasks. Applying the framework focuses the designers' attention upon whether the learning task that is constructed fulfills the pre-identified cognitive requirements of the learning task, and also whether the design utilizes the educational affordances of the tools in a way to support that cognition. The important point is that, based on the experience and expertise of the educational designer, the required affordances and available affordances are consciously considered.

It is acknowledged that there are many other pragmatic aspects of learning tasks that are not incorporated into this methodology (such as student ability, group allocation, motivation and assessment) and the educational designer will need to account for these. The above framework is focused upon supporting the matching of technologies with the cognitive and collaborative requirements of tasks.

By focusing on the affordances underlying the technologies the framework is adaptable to changes in technology. As well, by focusing on specific technological affordances and the actual cognitive requirements of learning, the framework presented intends to go beyond the broad generalizations that have been found in other articles addressing the integration of learning technologies (Kirschner et al., 2004; van Merriënboer, Bastiaens, & Hoogveld, 2004) to provide a detailed and specific approach to analysis.

An example – teaching introductory programming online

In 2005 Macquarie University launched a new online Graduate Diploma of Information Technology. This degree was built from the ground up, with the freedom to select technological and pedagogical approaches to best meet the needs of its graduate, distance students. Part of the challenge in designing this degree was determining which online tools should be used for different aspects of the courses. This section provides an example of how applying affordance analysis can help arrive at such a determination.

a) Identify educational goals

While there were certain aspects of the degree for which technology selection was predetermined (such as facilitating short online quizzes through the facility inbuilt in the Learning Management System), there were other educational components for which the most appropriate technology selection was not immediately apparent. The latter subset included:

Goal 1: facilitating student understanding of key concepts

Students acquire a preliminary understanding of key principles and concepts underpinning the various topics before coming to class, and can articulate those concepts.

Goal 2: facilitating students' application of knowledge to write computer programs

Students are able to write computer programs that meet predefined specifications.

The question of how to most effectively achieve these goals using online technologies was ambiguous to the development team.

b) Postulate suitable tasks

Identifying suitable tasks to achieve the pre-identified goals is a creative process.

Understanding key concepts

In order to develop their *understanding* of key concepts it was considered that students needed to be stimulated to respond to conceptual style questions that required them to interrelate pieces of declarative knowledge. In order to improve the quality of their understanding, an *evaluative* component (of self and peers) was deemed useful to promote critical reflection.

Apply knowledge to write computer programs

Students needed to be provided with design specifications and mini problem-solving tasks that required them to *apply* the conceptual knowledge they have developed in a topic and to *create* corresponding computer programs. It was considered that collaborative approaches to performing this task would be invaluable to provide students with troubleshooting support and the ability to discuss approaches with their peers.

These tasks were postulated, along with a variety of specific approaches to implementation that could be utilized. For instance, for the "understanding key concepts" task it may be desirable to have students collaboratively construct written responses to questions. On the other hand, in some instances it might be preferable for students to construct pictorial representations and receive asynchronous feedback. It was useful to consider more specific possibilities so that they could be kept in mind while analyzing the affordances of the available e-learning tools.

c) Determine affordance requirements of tasks

The affordance classification system previously presented provides a framework for specifying the affordance requirements of the task.

Understanding concepts, evaluating descriptions

In order for students to represent their concepts and evaluate those of others, "read-ability" and "write-ability" were deemed crucial. "View-ability" and "draw-ability" were required for information that lent itself to pictorialisation, whereas audio and video media affordances were not deemed necessary due to the more reflective, representational nature of the pre-class task. "Resize-ability" and "move-ability" would be useful to represent interrelationships between the declarative pieces of knowledge upon which concepts were based. "Synchronous-ability" was not considered mandatory – students could provide their conceptual responses and evaluate those of others in their own time. This meant that "accessibility" and "share-ability" would be pivotal. Some form of "record-ability" and "playback-ability" would be necessary for students to trace the development of concepts and arguments. If students were not engaging synchronously, "highlight-ability" would be required. In order to limit the size of group interactions and prohibit students from simply taking work from other groups, "permission-ability" would be necessary. Navigational affordances of "browse-ability", "data-manipulation-ability" and "link-ability" were deemed useful for reviewing, adjusting, and relating pieces of information respectively.

Applying concepts to create programs

In order to have access to immediate troubleshooting support and to be able to exchange ideas about program design in a timely manner, "synchronous-ability" and "share-ability" were required. To support rich collaboration, all media affordances were required. For instance, a student may want to broadcast their screen so another could provide audio support, while a third student was pasting pieces of code to a shared text area. The synthesis affordances were then desirable to combine and integrate the functionality of the various media forms to meet the needs of the particular task at hand. Of the navigational affordances, "browse-ability" (to review code) and "data-manipulation-ability" (to perform functions such as find and replace) were considered useful. To signify relationships between pieces of information, "focus-ability", "resize-ability" and "move-ability" were desirable. "Record-ability" and "play-back" ability were not deemed necessary (although potentially useful if students wished to review the process in which they had engaged).

These affordances requirements have been summarized in Table 2.

c) Determine technological affordances available

There are a large and ever increasing number of technology options available to educators. For illustrative purposes, three of the key technologies being considered for use in the Graduate Diploma of IT will be discussed: a discussion board tool (part of the WebCT Learning Management System); a wiki (Twiki); and a virtual classroom (provided through the Adobe Connect platform). This is obviously a small subset of the possible tools that an educational designer will have at their disposal – other technologies such as blogs, list-serves, instant messaging software and their varieties may also be considered. However, the three technologies selected for this example are suffice to demonstrate how affordances of the tools may be analysed so that they can be appropriately married to learning tasks. The affordances of these technologies have been tabulated in Table 3.

Note that different brands of tools within a particular technology type may offer different affordances. As well, because of the large range of tools available, the educational designer may choose not to document the affordances using the approach above. It is the process of consciously identifying the affordances offered by different technologies in order to determine the suitability of different types of tools that is being advocated. The experience and expertise of the educational designer is crucial (valued) in order to for these determinations to be made – the methodology merely supports the undertaking.

Table 2. Example: diagnosing the affordance requirements of two learning tasks.

Affordances: / ***Task***	read-ability	view-ability	listen-ability	watch-ability	write-ability	draw-ability	speak-ability	video-produce-ability	resize-ability	move-ability	playback-ability	accessibility	record-ability	synchronous-ability	browse-ability	search-ability	data-manipulation-ability	link-ability	highlight-ability	focus-ability	combine-ability	integrate-ability	permission-ability	share-ability
Understand concepts, evaluate descriptions	✓	✓			✓	✓			✓	✓	✓	✓	✓		✓		✓	✓	✓				✓	✓
Apply concepts to create programs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓			✓	✓	✓		✓

Table 3. Example: affordances of some available technologies.

Affordances: / ***Technology***	read-ability	view-ability	listen-ability	watch-ability	write-ability	draw-ability	speak-ability	video-produce-ability	resize-ability	move-ability	playback-ability	accessibility	record-ability	synchronous-ability	browse-ability	search-ability	data-manipulation-ability	link-ability	highlight-ability	focus-ability	combine-ability	integrate-ability	permission-ability	share-ability
Discussion Board	✓				✓						✓	✓	✓		✓			✓	✓				✓	✓
Wiki	✓	✓			✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓				✓	✓
Virtual Classroom	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

d) E-learning task design

This is the creative and synergistic process of selecting appropriate technologies and tightening task definitions.

Understanding concepts, evaluating descriptions

Based on the affordance requirements of the task (Table 2) and the affordances offered by different tools (Table 3), it was evident that the discussion board is insufficient to support the "understanding key concepts" task. It does not provide the ability to represent diagrams or view them. Nor did the discussion board provide the ability to manipulate data, which is crucial if students are to build on the mental models of others. On the other hand, the wiki was sufficient to meet all requirements of the "understand key concepts" task.

Once the wiki has been selected as the tool of choice, it was possible to more tightly design the task. In the case of the Graduate Diploma of Information Technology, a set of preliminary conceptual questions were prescribed each week which students attempted before coming to class. Students were placed into groups and posted their thoughts to their group's wiki space. If another student had already posted a response then it was up to the next student to correct the description or embellish it. During class, students were granted access to other groups' work and asked to provide evaluative feedback.

Applying concepts to create programs

Based on the affordance analysis, the only platform that could in itself satisfy the task requirements was the virtual classroom. The additional affordances of "link-ability", "highlight-ability",

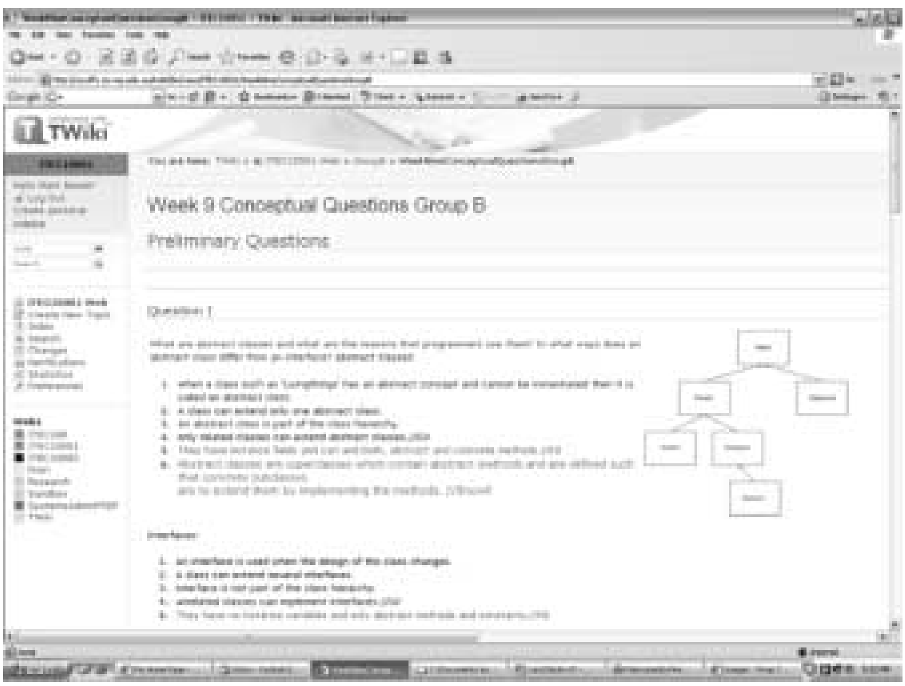

Figure 2. E-learning design: a TWiki wiki to facilitate understanding of concepts and evaluation of descriptions.

and “permission-ability” that it offered were not likely to be useful for the “apply concepts to create programs” task. However, they were also unlikely to be distracting because the sensory signals that underpin them are not at the forefront of the interface (meaning no effort was necessary to hide these affordances). On the other hand, “record-ability” and “playback-ability”, which were not identified as required in the original requirements analysis, could actually be useful to students if they wish to review the process in which they (or other students) had engaged. This could then be incorporated into the task prescription, to improve the overall design of the task (which represents an iteration between the requirements determination and e-learning design stages of methodology).

Once the virtual classroom tool had been selected for the “create programs” task type, more detailed design was able to be performed. The ability to combine and integrate tools within the virtual classroom meant that it was possible to match the interface design to the specific requirements of the task. For instance, the task illustrated in Figure 3 required students to combine applet drawings into a single canvas, based on the documentation that was included with the drawings. The screen-sharing pod could be used to allow students to share their programming process knowledge. The notes pod was deployed to facilitate collaborative writing of pieces of code. The Voice Over IP tool allowed students to conduct audio discussion to support the visual process and their textual exchanges. Students were given the highest level of permission in the room so that they could resize tools, and drag and drop new tools into the interface as their collaborative requirements changed. For example, the whiteboard could be used to communicate about spatial concepts if the need arose. Pointer tools and the ability to draw over the screenshare provided the ability to synchronously emphasize key aspects of the content being considered. The task specification also required students to record their collaborative sessions so that they could compare and contrast their approach with other students, as a means of developing critical and self-reflective thinking skills.

Conclusion

The success of educational technology implementations is dependent on the educational developer’s ability to appreciate the requirements within the learning context and subsequently select

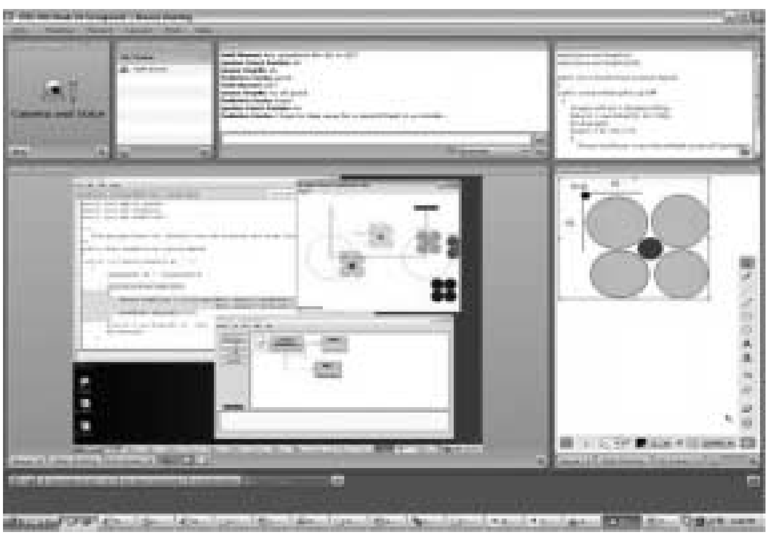

Figure 3. E-learning design: a virtual classroom to apply concepts and create programs.

and utilize technologies in a way that meets those needs. Constructing a general, relevant approach for supporting that process is both challenging and contentious. The methodology proposed in this article advocates the process of consciously identifying the affordance requirements of a learning task and how they can be satisfied by the inherent affordances of e-learning technologies. Focusing on an affordance level draws the educational designer's thinking closer to the underlying attributes of the technologies and how they support collaboration and cognition, allowing selection to be based upon learning needs.

It is acknowledged that the subtle interactions between affordances and the details of how they operate have a major impact on the learning experience, and as such no formula will ever be possible for designing educational tasks. Thankfully, learning design will always comprise an element of artistry. However, it is proposed that there are various levels of awareness at which design tasks can be performed. In the emerging era of technology-based learning, this means having a portfolio of approaches for identifying, describing, analyzing and allocating technologies for deployment. Affordance analysis provides such a methodology which concentrates directly on the critical aspects of the selection process: the underlying features of tools and the cognitive and collaborative requirements of learning tasks.

Acknowledgement

This research was supported by a Macquarie University Strategic Curriculum Innovation Grant.

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