THE ECOLOGY MODEL OF LEARNING: EVALUATING DIGITAL MEDIA APPLICATIONS (DMAS) USING ESTABLISHED ECOLOGICAL SUBSYSTEMS OF LEARNING

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ABSTRACT

Digital media applications (DMAs) have emerged in abundance over the last ten years. Enabled by exponential growth in computing power and inexpensive data storage, these applications are easy to use and inexpensive (often free) to own. DMAs not only allow users to produce digital content efficiently they allow users to exploit the connective power of the Internet to distribute their work. These affordances are allowing users to connect with others in significant ways enabling entirely new ecosystems built around collaborative learning and discovery. The purpose of this article is to build a linkage between the interactivity of digital media applications and an ecological model of learning that is also built on the concept of interactivity. The ecological model postulates that the learner interacting with the environmental conditions is important to learning. The paper describes the ecological model of learning and how the "subsystems" of the model can serve as an evaluation rubric for DMAs. The authors conclude that developers of DMAs are creating environmental conditions conducive to learning based on ecology. Based on this analysis they provide several recommendations for selecting applications for learning and for strengthening these learning environments.

Keywords: Digital Media, Ecology Model, Learning, Learning strategy .

INTRODUCTION

Digital Media and Learning

In less than two decades digitized content and emergent tools used to produce and distribute that content have afforded individuals the ability to create powerful forms of social organization. Uncomplicated and inexpensive (often free), digital media applications (DMAs) allow individuals to create and publish content in a variety of forms, and to reach audiences unparalleled by previous medium. Many DMAs are now leveraging the Internet's connective power, allowing people with similar interests to locate each other and build on their common and divergent understandings. Furthermore, these affordances are the focal point of a growing body of emergent research. Gee (2010) suggests that digital media and learning (DMAL) is emerging as a thematic discipline that cuts across many different academic specializations. Researchers from a variety of academic disciplines (e.g. sociolinguistics, psychology, education) have converged thematically to form this new area of focus; many suggest that this theme will grow into a field or discipline. The interdisciplinary nature of this thematic discipline resonates with the overall and current nature of 21st century research. A foundational theory of complex systems underpins the emergent discipline of DMAL and attracts researchers from many disciplines who are being challenged to solve compound problems that continue to plague modern society (Gee, 2010). The focal point of this paper is to build associations between the interactive affordances that are provided by DMAs and an ecological model of learning (based on complex systems) that is also built on the concept of interactivity. The article describes the ecological model of learning and how the "subsystems" of the model can serve as an evaluation rubric for DMAs.

Ecological Model of Learning

Ecology models are focused on the transactional / interactivity of behavior, person variables, and environmental conditions. Historically, the interest in the environmental conditions of learning is built on the early work of John Dewey (1916) in his book Democracy and

Education. Later, Lewin (1938) formulated the ecological structure of behavior as a function of the person in relationship with their environment. Kolb (1984) stated this premise focusing on learning, saying that "learning arises as a product of interaction between the person and his or her environment" (p. 5). Despite this long tradition of an ecological perspective on learning, most learning theories have focused on the dispositional attributes of the learner and most often not addressing the environmental conditions associated with the learning process. One exception is the work of Blocher. Blocher (1987) stated that "a learning environment is essentially a physical, social, and psychological context within which people acquire new behavior; that is, they learn" (p. 62). Most important to the purpose of this manuscript is Blocher's learning model that outlines the important environmental conditions that are associated with learning. It is this model and its framework of subsystems that can serve as a rubric to explore and evaluate emergent digital media environments for learning.

Blocher's ecological approach to learning along with other ecological approaches (Bronfrenbrenner,1979 & Vygotsky,1978) were published in the late 1970s, but it is nearly twenty years later that the use of the ecological approach to understanding e-learning appears in the literature according to Frielick (2004) pointing to the work of Nordi & O'Day (1999), Brown (2000) & Garrison & Anderson (2003). The use of the ecological approach in relationship to e-learning continues to gain acceptance (Gutl & Chang, 2008 & McCalla, 2004), however, the notion of using an ecological framework as a rubric to explore and evaluate emergent digital media environments for learning has not been addressed. Blocher's work is important to this idea, in that it clearly outlines the important environmental conditions that are associated with learning in detail and in practical terms. Most recently, the use of the Blocher model's ecological subsystem structure has been applied to the delivery of health services (Banning & Kuk, 2005) and to the organizational learning environment (Kuk, Banning, and Amey, 2010). This paper introduces the model to the e-learning environment and present subsystems of the model as a rubric to explore and evaluate emergent digital media environments for learning.

Blocher's (1974, 1978) multi-pronged model focuses on the student-learning environment and relationships. The organization of the ecological model of learning is an open systems model that includes three subsystems: the opportunity subsystem, the support subsystem, and the reward subsystem (described below). These three subsystems organize how one thinks about a learning environment. Learning is defined as "the acquisition and maintenance of new patterns of thinking that are qualitatively different from proceeding patterns" (Blocher, 1974, p. 19). Blocher's three-pronged framework aligns, and therefore retains currency and validity, with the characteristics outlined in current ecological literature (Pickett & Cadenasso, 2002; Gutl & Chang, 2008). The characteristics and alignment include

- living and non-living environmental conditions (aligns with Blocker's opportunity subsystem),
- temporal special relations (aligns with Blocker's opportunity subsystem),
- relations and interactions (aligns with Blocker's support subsystem),
- constraints and feedback loops (aligns with Blocker's reward subsystem).

A description of each of Blocker's model subsystems is provided below.

The opportunity subsystem provides the available tasks or opportunities for new learning. The new learning associated with these opportunities is increased according to the ecological model by the environmental conditions that involve challenge and provide for integration of new and old learning. Involvement calls for personal engagement in the learning task that puts at risk significant personal values and previous knowledge. To increase the challenge of a learning opportunity, the variables of novelty, complexity, abstractness, ambiguity, and intensity need to present. Finally, in addition to the tasks needing to be involving and challenging, they also need to be provided for integration.

Attention to Blocher's second subsystem, the support subsystem is also important. The support subsystem focuses on the notions of structure and support. Structure,

according to Blocher, "provides a new and higher level way of processing and organizing information about some phenomenon" (Blocher, 1974). Support is defined as the "need to provide a relationship network that communicates empathy, caring, and honesty" (Blocher, 1974, p. 21) so that learners are not fearful to engage new ideas and models. Particularly important for learning is the creation of a climate that is perceived and experienced as a safe place for new thinking, new models, and new relationships.

Finally, the third Blocher subsystem is the reward subsystem. The reward subsystem is critical in bringing about feedback and application. Blocher (1974) defines feedback as "a condition that gives... continuous, accurate, and unambiguous information" (p. 21). The reward subsystem also includes the concept of application. New learning will be enhanced if it has applicability.

Methods

Translation of the Ecology Model to Digital Media and Learning

Important to the notion of using the ecology model of learning as a rubric for exploring and evaluating DMAs is using the three subsystems to view emergent applications. These subsystems translate rather seamlessly and provide the framework for three of the four research questions being considered. The subsystem of opportunity calls for the users to become significantly engaged in the application's activity. To become fully involved, old learning needs to be put at risk with new learning being provided by the application. If the application is seen as presenting a challenge, then more of a learning potential exists. DMAs that are viewed as novel and complex would contribute to this condition. Furthermore, this subsystem can provide an opportunity for reflection and time to assimilate the new learning. For this study, the research question being investigated is the following. *Question 1: Do DMAs provide opportunity through environmental conditions that both challenge old ways and integrate new ways of learning?*

The *subsystem of support* provides a framework to help reduce the stress associated with the new learning. DMAs that are built on previous "structures" would be viewed as moving toward this condition. For example, some applications are built upon skills and activities that the learner acquired through use of static web-based sites and applications. The "static" web is often referred to as Web 1.0. The support subsystem also relates to the "help" systems built into the application, the network of support persons available via the providers of the application, as well as a network of application users. The question under consideration in this study is the following. *Question 2: How prevalent and transparent are systems of support within DMAs?*

The reward subsystem includes the important concepts of feedback and application. Feedback for new learning is enhanced when it is continuous, accurate, and unambiguous. The interactive messages provided to the new user by the DMA would be important in meeting this condition. The notion of application is also a key part of the reward system. DMAs which can foster the user's application of learning to other situations would be contributing to Blocher's reward subsystem. *Question 3: Do the DMAs provide continuous, accurate, and unambiguous feedback to new users?* The premise of the foregoing is that the degree to which DMAs can contribute in a positive way the fulfillment of the ecological subsystems of learning, the more useful the application will be in the learning environment.

DMA selection

Since 2007, the Center for Learning and Performance Technologies has established a categorical listing of the top digital media learning tools. These tool categories are compiled through a voting process; 278 learning professionals (e.g., training consultants, educators, CEOs, instructional designers) voted during 2009. The list provides a framework for organizing the various DMAs that are vital to professionals working in the digital media and learning space. Examples of these categories include screen capture tools, social bookmarking tools, instant messaging, and presentation sharing tools (Hart, 2009).

For this study, an analysis was conducted for the top ranked tool within each of the 25 categories as identified by the Center for Learning & Performance Technologies. This list included both online web-based DMAs and more traditional personal computer-based applications like

Microsoft PowerPoint and Word. For this study PC-based applications that provided limited connectivity to external references and user groups were eliminated from study. Table 1 provides a listing of the DMA categories and the top-rated tools that were selected and investigated in this study. These tools include articulate, Audacity, delicious, dimdim, elgg, Evernote, Firefox, flickr, FreeMind, Gmail, Google docs, Google reader, Google sites, iGoogle, Jing, moodle, Ning, Prezi, skype, slideshare, SnagIt, twitter, Wikispaces, WordPress,YouTube.

Data Analysis

Coding Procedure

The study utilized the methodological framework of emergent qualitative document analysis (QDA) (Altheide, Coyle, DeVriese, & Schneider, 2008). QDA is a qualitative content analysis which examines documents or media for the "emergent patterns" (Altheide, 1987, p. 65) rather than the typical hypotheses-driven classical content analysis (Kripppendorff, 2004). Within the QDA framework of this study, a deductive coding procedure (Boyatis, 1998) was employed whereby the codes were developed directly from the Blocher's (1974, 1978, 1987) ecological model of learning. This method allowed a priori codes of opportunity, support, and reward to be utilized as a deductive approach to the data. In other words the analysis was theory-driven rather than an inductive data-driven approach which allowed the basic question of the study to be addressed: how can the subsystems ecological learning model (opportunity, structure, and reward) can serve as an evaluation rubric for DMAs?

Digital Media Category	Digital Media Application	Digital Media Ranking
Micro-blogging	twitter	1
Social Bookmarking	delicious	2
Video tools	YouTube	3
RSS/Feed Reader	Google reader	4
Online office suite	Google docs	5
Blogging tool	WordPress	6
Presentation sharing	slideshare	7
Web Browser	Firefox	8
Audio/podcasting tools	Audacity	9
Presentation tool	Prezi	10
Instant Messaging	skype	11
Social networking	Ning	12
Course management	moodle	14
Personal dashboard	iGoogle	16
Image/photo tool	flickr	18
Demo/Screencasting	Jing	20
Email	Gmail	21
Course authoring	articulate	24
Screen capture	SnagIt	25
Personal Productivity	Evernote	27
Wiki tool	Wikispaces	29
Web conferencing	dimdim	43
Integrated social media	elgg	53
Mind mapping	FreeMind	71
Web authoring	Google sites	72

Table 1. Rank order listing of DMAs analyzed in this study. Listing established by category.

The process of peer debriefing was used to insure trustworthiness (validity) of the deductive coding process (Creswell, 2007). The manuscript authors examined the application of the deductive codes through discussion and the final assignments of the codes were determined by consensus.

Coding scheme

As noted above, building on the theoretical input of Blocher's ecological model of learning, three coding categories were defined and used for the deductive data analysis. The analysis and understanding was organized around these three a priori codes: opportunity, support, and reward subsystems. The following provides the information regarding the definition and implementation of these codes:

Opportunity

In an effort to qualify ecological opportunity that the identified DMAs afford, the researchers analyzed each application's homepage, about page, Wikipedia entry, and the Social Learning Handbook (SMIL) tutorials. In their effort to uncover meaning the authors looked for evidence that suggested novelty, complexity, abstractness, ambiguity, and integration of previous experiences. They also looked for thematic evidence that, individually and collectively, these applications encouraged significant engagement in the application's activity.

Support

Textual information from online help systems was analyzed to determine how each DMA connected its functionality to previously held or learned models. Text from each help

system, Google search, and internal application searchers were collected and analyzed. The authors examined how each DMA provided this type of scaffolding support within and surrounding their support system.

Reward

In an effort to evaluate ecological rewards the authors attempted to enter each DMA as a new user. They engaged with the application's apparent functionality and then collected and analyzed feedback / messages that were provided to the new user or learner. They analyzed feedback based on message accuracy, timeliness, and ambiguity. Furthermore, after receiving initial rewards, they followed the suggested feedback and direction and continued to look for additional or continuous feedback and rewards.

Results

Overall the content analyzed provided multiple references and text describing a strong and unique ecological system of learning. From Table 2, the frequency of coded text varied for each DMA analyzed. Some of the applications had few references (as few as one) and other applications had upwards of 50 textural references describing novelty, complexity, abstractness, ambiguity, and integration (opportunity subsystem). Textual references related to the support subsystem were also prevalent and varied. Five of the DMAs were coded as providing little to no support, while four applications were coded with over 15 times indicating a clear attempt to connect to previous learning. Furthermore, there emerged a clear indication that digital media developers are attempting to build reward-based ecosystems. The majority of the applications that the authors were able to analyze provided timely and accurate feedback messages or rewards. As is indicated under the reward subsystem column, several of the applications could not be analyzed because they required specialized downloaded software or server-based installation for operations. In these instances the reward subsystem was marked as not analyzed (N/A). As is indicated by a 'YES' those applications that were analyzed provided contextual-based feedback for the new users. Clear examples of these types of rewards are illustrated below.

Digital Media Application	Digital Media Category	Ecological Subsystem		
		Opportunity	Support	Reward
articulate	Course authoring	2	0	N/A
Audacity	Audio/podcasting tools	10	1	N/A
delicious	Social Bookmarking	8	5	Yes
dimdim	Web conferencing	12	1	Yes
elgg	Integrated social media	34	0	N/A
Evernote	Personal Productivity	17	3	Yes
Firefox	Web Browser	3	2	Yes
flickr	Image/photo tool	13	9	Yes
FreeMind	Mind mapping	1	0	N/A
Gmail	Email	9	12	Yes
Google docs	Online office suite	17	12	Yes
Google reader	RSS/Feed Reader	54	7	Yes
Google sites	Web authoring	1	8	Yes
iGoogle	Personal dashboard	11	0	Yes
Jing	Demo/Screencasting	10	0	Yes
moodle	Course management	5	8	N/A
Ning	Social networking	15	27	Yes
Prezi	Presentation tool	21	7	Yes
skype	Instant Messaging	9	6	Yes
slideshare	Presentation sharing	3	14	Yes
SnagIt	Screen capture	11	16	N/A
twitter	Micro - blogging	43	18	Yes
WordPress	Blogging tool	13	5	Yes
Wikispaces	Wiki tool	20	11	N/A
YouTube	Video tools	2	5	Min.

Table 2. Alphabetical listing of DMA, identified tool category and related frequency of coding for opportunity, support, and evidence of new user rewards.

Opportunity Subsystem

In total, the opportunity subsystem was referenced 344 times. Within this total, novelty was coded 65 times, complexity 129 times, abstractness 26 times, ambiguity 26 times, and integration 98 times. Details and examples of each of these coded passages and descriptive evidence that indicates an opportunity subsystem is provided below.

Novelty

Regarding novelty many websites described the uniqueness of their application. For example, Prezi self-reported that, "it's an entirely Flash-based application that lets you break away from the slide-by-slide approach of most presentations. Instead, it allows you to create non-

linear presentations where you can zoom in and out on a visual map containing works, links, images, or videos" (prezi.com). Wikispaces (wikispaces.com) indicated that "the majority of tools exist to publish content on the Internet are either one-to-many (e.g. personal websites, blogs, news sites) or short lived (forums / message boards, FAQs, etc.). Wikispaces gives groups the freedom to publish pages that are long-lived, regularly updated, and built by many contributors." Furthermore, novelty was identified in statements such as "Firefox has more than 6,000 add-ons to help you customize it to your exact needs, plus thousands of Personas to instantly change the way it looks" (firefox.com).

Complexity

Complexity was noted with regularity among the textual references and was noted in two general ways. First the majority of the websites provided some reassurance of ease-of-use. For example, "quizmaker makes it easy to create quizzes that you can integrate with articulate presenter '09 courses and presentations" (articulate.com). "Well we made it our mission to create an easy, open, affordable web conferencing system as simple to use as the iPod" (dimdim.com). Or, "with security, stability, speed and much more, Firefox is made the way you use the Web. Free and easy to install" (firefox.com).

Second, complexity was also noted as providing opportunity to expand learning and knowledge acquisition related to digital media use. For example, "Evernote plug-ins are available for some major Internet browsers that allow web pages to be captured, either as simple bookmarks (with annotations) or full pages" (evernote.com). Or, "and we want to be able to push them out in as many ways as possible: on the flickr website, in RSS feeds, by email, by posting to outside blogs or ways we haven't thought of yet" (flickr.com). This type of complexity included verbiage as extreme as, "to run elgg, you need to have your own web server and a certain amount of technical knowledge – or access to someone who does, like a system administrator" (elgg.org).

Abstractness and Ambiguity

Several abstractions and ambiguities were coded under the opportunity subsystem. These included passages like, "besides the different entity classes in elgg, there are three helper classes that makes it easy to add new functionality. The elgg Relationship class allows you to quickly establish connections between entities" (elgg.org). Furthermore, "Evernote allows to easily capture information in any environment using whatever device or platform they find most convenient, and makes everything accessible and searchable at any time, from anywhere" (evernote.com). And finally, "the timely bits of information that spread through twitter can help to make better choices and decisions and, should you so desire, creates a platform for you to influence what is being talked about around the world" (twitter.com).

Integration

Several passages were coded as providing a connection or integration with previous experiences. These included such statements as, "just like bank and credit card websites, Gmail uses always-on HTTPS encryption to keep your mail secure, so someone sharing your favorite coffee shop's public wifi can't maliciously read it" (google.com). Textual description of articulate.com indicated that, "Articulate presenter '09 saves your content in the universally accepted Flash format, so it runs on any Web server or LMS. It also creates SCORM and AICC-compliant content so you can easily track results on your learning management system (LMS)." And, "Articulate presenter '09 makes it easy for anyone to add interactivity and narration to PowerPoint slides. Just click a button to turn your presentation into a compelling Flash course" (articulate.com).

Support Subsystem

It was apparent that application developers had made a concerted effort to scaffold between preexisting concepts and the new ordering and structure of their DMAs. There was considerable verbiage that attempted to bridge between the known and the unknown such as, "flickr is the WD-40 that makes it easy to get photos or video from one person to another in whatever way they want" (flickr.com). As we coded these support-based statements, a natural order emerged and several subthemes were identified and used for understanding. These scaffolding subthemes included abundance, control, customization, organization, and publishing. Textual reference from each of these

subthemes is highlighted below.

Abundance

The idea of information abundance was repeated in textual reference on almost all the DMA websites. For example, the Gmail website noted that, "with all the space, you can archive instead of deleting messages, so they won't clutter your inbox but will remain searchable in case you ever need them again" (google.com). Furthermore, this concept of abundance is reinforced repeatedly as the majority of these services are free to the user. "The best part is – It's completely free" (slideshare.com) is a common statement that helps users bridge the gap (scaffold) between a world based on scarcity to one based on abundance.

Control

Control of what information is shared and how it is distributed emerged as a theme and a considerable amount of effort was made to help users understand and reach an acceptable comfort level with its maintenance. Even twitter, an application that was designed to be extremely open, stated that, "if you're hesitant to have strangers read your updates, protect your profile to approve followers and keep your updates out of search" (twitter.com). Similarly, wikispaces.com attempts to help users reach a comfort level stating that you "determine who can access your wiki by setting wiki permissions. Make it open to the public, protected from editing by non-members, or completely private."

Customization

Having the ability to customize the online experience using DMAs was a theme that emerged and considerable support was given to helping users personalize their experience. Several sites explained how widgets can be embedded to create a customized experience. For example, "an embedded widget is a piece of content from an outside website that's placed directly into your Ning network, just as it appears on the outside website. This can be a video from an outside video service like YouTube or Hulu, a game or application that adds a new functionality, or even a media player from a different Ning network" (ning.com).

Organization

There was considerable effort to explain and help the user understand the significance of new structures and thinking about search and metadata to organize and contend with the abundance of information. It was clear that an effort was being made to help users scaffold between the old way of thinking based on storing information in folders (scarcity thinking) to a new way of thinking based on "don't worry about organization" simply store it and then search it (abundance thinking). For example, "you don't have to spend time sorting your email, just search for a message when you need it and we'll find it for you" (google.com/gmail). Furthermore, "folders were the old way to organize your bookmarks. They were great if you only had a few bookmarks and a few folders, but as your collection grew, it became harder and harder to decide what goes where. Delicious has a new way and better way: tags" (delicious.com). Flickr attempts to help users deal with the abundance of information explaining that, "part of the solution is to make the process of organizing photos or videos collaborative. In flickr, you can give your friends, family, and other contacts permission to organize your stuff – not just to add comments, but also notes and tags" (flickr.com).

Publishing

The idea that content can be easily published and republished emerged as one of the strongest themes related to supporting the user. This theme was consistent across the DMAs including delicious.com a web-based bookmarking site where it was stated, "…do you like to share cool or funny websites with your friends? Or do you know people who are always finding interesting stuff? Delicious hooks it all together. You can share bookmarks with your friends on delicious, your twitter universe, or friends and family via the old-school way – electronic mail." As another example Prezi.com describes how "you can invite others to view or edit your Prezi, and obtain an embed code to easily add the Prezi to your blog."

Reward Subsystem

Acting as a naive new user we "signed up" for an account and looked for reward messages and feedback that was timely and accurate. We were limited to analyzing the DMA

that allowed for online use or applications that require minimal download and setup. It was determined that 18 of the 25 DMAs could be analyzed in this manner. Furthermore, 17 of the 18 applications provided feedback that was both timely and accurate to the new user. The authors have included examples of these feedback messages below.

The majority of the tools analyzed had introduction screens that provided step-by-step instruction on how to get started using the application. For example, dimdim.com provided the following large "start" button that launched the new user into the application. Figure 1 provides a screen capture of the initial dimdim reward screen provided to the new user.

Firefox provided very useful information to the new user. Figure 2 provides a screen capture image of Firefox's initial setup screen. On this screen the new user can begin to customize the fit, form, and function of the Firefox browser by clicking on the hyper-sensitive images within the browser. As these images are clicked, the browser is instantly customized to the new users' preferences.

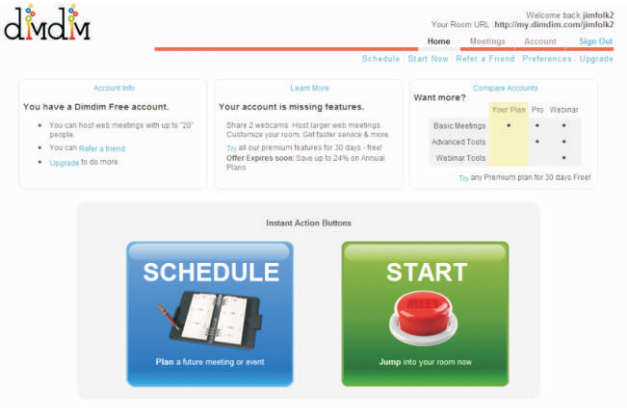

Figure 1. Screen capture of dimdim's reward system feedback.

Figure 2. Screen capture image of Firefox's reward system feedback. New users can customize the fit, form, and function of the browser instantly by clicking on the hyper-sensitive screen.

Gmail provides a welcome screen that leads the new user to helpful, timely, and informative information. Figure 3 provides a screen capture image of the welcome screen that describes some of the unique features of Gmail including archiving, chat, and labels (tags) for organization.

Illustrating one more example, Jing provides several timely short videos that describe its DMA. A screen capture image is included below of the "Learn Jing Now" tutorial that walks new users through the basics of Jing (Figure 4). Additional

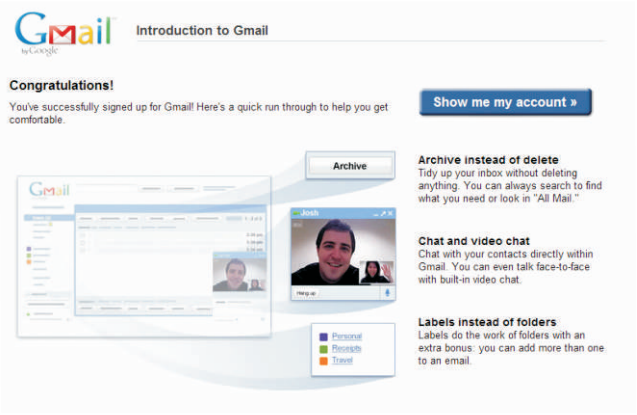

Figure 3. Screen capture image of the "Introduction to Gmail" screen.

Figure 4. Screen capture image of Jing's "Learning Jing Now" tutorial. These video-based tutorials require the new user to engage in using the tool.

videos are available, including tutorials on how to capture specific types of Jings and how to share Jings using the Web and embedded code. These video tutorials are interesting because they have been designed to engage the new users in using the Jing tool as they learn. The tutorial requires that the user engage in using the Jing tool to capture images and recognizes if the new user has done it correctly. If the new user fails to use the tool properly it redirects the user and replays the tutorial.

Discussion

The purpose of this study was to build associations between DMAs and Blocker's ecological model of learning that was also built on the concept of interactivity. A deductive coding scheme was developed based on Blocher's subsystems (opportunity, support, reward) and used to evaluate the top 25 DMAs as identified by the Center for Learning and Performance Technologies (Hart, 2009). Based on these findings, the following discussion provides a description of how these DMAs connect to Blocher's ecological model of learning. This discussion is organized around the four research questions proposed and investigated in this study.

Question 1: *Do DMAs provide opportunity through environmental conditions that both challenge old ways and integrate new ways of learning?* Based on Blocher's model, the applications analyzed provided ample opportunity for learning about the DMA itself and the larger ecosystem within which they operate. Multiple references and inferences were made to novelty, complexity, abstractedness, ambiguity, and integration. It was apparent from the analyses that the designers of the DMAs were not simply providing applications that allow the user to complete common tasks such as placing a Microsoft Word document online (e.g., Google documents), but were providing opportunity for users to learn about a complex and new ecosystem that is based on self-publishing, sharing, and abundance. This opportunity was revealed across the analyzed DMAs. Furthermore, it appeared that the majority of the DMA developers had considered the new user and made efforts to help those learners bridge the gap between current learning and the emerging learning condition based on abundance (see section below implications for ecological learning for description of condition base on abundance).

Question 2: *How prevalent and transparent are systems of support within DMAs?* As was stated above, it was apparent that application developers had made a concerted effort to scaffold between existing knowledge (scarcity paradigm) and the new ecosystem of collaborative learning. Analysis of a variety of online help systems revealed emergent themes that appeared to be designed to bridge the gap to the new learning paradigm and therefore effective use of the DMA. These themes included the concepts of abundance, control, customization, publishing, and self-organization.

Question 3: *Do the DMAs provide continuous, accurate, and unambiguous feedback to new users?* The reward systems varied significantly from application to application. Some applications contained very sophisticated operation-based rewards that simulated and rewarded successful use, while rewards were completely lacking in other applications. It seemed clear that those with reward based-feedback provided more opportunity for a new user to understand the DMA's use and fully benefit and operate within the new environment. Although the authors saw evidence that DMA developers spent considerable effort to provide rewards (timely feedback), these rewards appear to stop after the new user was initiated. Considering the fact that rewards are limited, it is unclear whether the user will be able to transfer their initial learning, or how successful they will be at using the DMA to its fullest potential beyond the initial simulation. The authors believe that this unknown provides fertile ground for future investigation and research.

Implications for ecological learning

The authors are witnessing a major shift in how information is produced and distributed. In Clay Shirky's (2008) book 'Here Comes Everybody' he explains that the proliferation of free digitization tools and free distribution channels shift our world from one based on scarcity to one based on abundance. They no longer ask, 'why publish' but we say, 'why not publish' and distribute digital content in mass, indiscriminately, and without regard to quality. This creates an abundance of information, information that floods the

market for our attention and of course overwhelms, or circumvents a system that previously relied on gatekeepers or editors to peer review content before it was sent public.

Internet connectivity and digitization of content didn't simply introduce new competitors into a current ecosystem, it introduced a new ecosystem. As with any radical disruption at an ecosystem level, one witnesses mass extinctions. In fact, any existing profession that has been built on scarcity now faces extinction or significant change. Librarians, journalist, and educators are examples of professions that are currently facing ongoing radical change. As is suggested, survival will require a paradigm shift in the way we approach and operate in this new ecosystem. Those that learn to operate in this ecosystem will survive. Those that lag behind will be trapped in the "tar pits" of the old system hanging onto the notion that information is scarce while in fact information is literally everywhere.

Making this shift will require individuals to learn to operate with abundance. That is, they need to build socially constructed ecosystems to survive. Why? Because it is through these social connections that information abundance becomes manageable and can be leveraged for success. Learning to operate in this new environment, individuals need to learn to filter content, customize their resources, and becoming engaged in communities as publishers of their own content.

In disruptive periods adaption is vital to survival. Those that learn through tinkering and experimentation will thrive while others follow. We suggest this is why, when asked, many individuals involved in the struggle to learn to operate in this new abundance-based ecosystem, suggest that 'you just start doing it.' It is difficult to explain how one learns or operates in this new ecosystem because we are still developing theories and ways of explaining it. For example, connectivism (learning theory) is a theory espoused by George Siemens (Siemens, 2010) to explain the effect technology has had on how we live, how we communicate, and how we learn. Although this is a well received theory, its abstractions are foreign to our current system making it difficult for most to embody.

Blocker's ecological model of learning provides a framework for reflection and evaluation of this new ecosystem. It provides a way to evaluate how DMAs may help us make the paradigm shift that will allow us to thrive in this environment. The researchers suggest that using Blocker's ecological subsystems as a rubric may be useful to educators, learners, and developers. Educators may want to use Blocher's model when selecting a DMA for use in the classroom. Teachers interested in helping students learn how to operate in this new information rich environment can use Blocher's model as a rubric to identify DMAs that establish a favorable ecology for learning. Selecting DMAs that enhance the environment, and support shifts in thinking, will reinforce new behaviors -- behaviors that are vital for future success. For example, although elgg received 34 for opportunity it was coded zero for support (Table 2). Therefore, if educators use elgg as a social media tool in the classroom they may need to provide additional scaffolding. Alternatively they may use the process outlined in this paper to identify an alternative DMA that provides such support.

In addition, application developers may consider using the process described in this study to benchmark their DMAs. For example, developers may want to consider Jing's reward system as its support system as it provided unique (unique among the DMAs evaluated) interactive simulation and directed feedback. It is suggested that application developers may want to continuously benchmark and improve their application's ecological structure, providing ecological support for learning and ultimately application use and adoption.

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