

Use of New Technologies in Distance Education: The Case of Operations Management

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Universities have been using the Internet as the backbone of distance education for the past 15 years, but Web 2.0 tools are literally changing the face of distance learning. Which tools are useful and which are not yet worth the investment of one's time? In this paper, we discuss some of the available Web 2.0 tools, describe how they are used, and summarize the appropriate use of different Web 2.0 technologies, differentiating between graduate and undergraduate Operations Management classes. We conclude with a discussion of potential new technologies and future research goals.

I. INTRODUCTION

Distance and e-learning have become firmly established in higher education in the United States and elsewhere. A recent study found that during the fall 2007 term, over 3.9 million students in the U.S. were taking at least one online course — more than double the number from fall 2002 (Allen and Seaman, 2008). Online enrollments have grown at a rate of 12.9% per year, far exceeding the overall growth rate of higher education enrollments. Over 20% of all higher education students in the U.S. are now taking online classes (Allen and Seaman, 2008), and more than 30% of all faculty have taught an online course (APLU, 2009).

At the same time, the technology available for online education has changed dramatically. The development of Web 2.0 tools, such as wikis and podcasts, has significantly expanded the ways that instructors can deliver content and facilitate distance learning. Some of these tools are simple, while others are complex.

Some tools are geared toward one-way, asynchronous delivery of information, while others are designed to facilitate multi-way, real-time communications. While much research has been devoted to studying the efficacy of online learning from the students' perspective, little or no work has addressed the instructors' perspective. This paper seeks to fill this void by providing guidance on which tools are most useful for teaching Operations Management (OM) concepts.

The analysis and recommendations are based on our direct experience using various tools at a mid-sized public university, which began its online education program in 1996. Collectively, we have been teaching three to six classes online every year since the inception of the online program. Over the years, it has been a constant challenge to decide whether to apply the latest teaching technology tool or not. For example, Second Life — an Internet-based simulation that allows the building of virtual worlds — is an appealing option for bringing

virtual worlds to students. However, when there are examples where 400 hours of time was invested for developing a fairly simple virtual world (in this case, the house in a novel where most of the book takes place), it suggests that more development is needed before it is useful. This paper provides a primer on the variety of distance learning tools available today along with how and when to use the various tools effectively.

The remainder of the paper is organized as follows. Section 2 provides a brief review of the literature related to distance learning. Section 3 presents a detailed review of e-learning applications and provides examples of how and when to use the different tools. Conclusions and directions of future research are presented in Section 4.

II. RESEARCH LITERATURE ON DISTANCE AND E-LEARNING

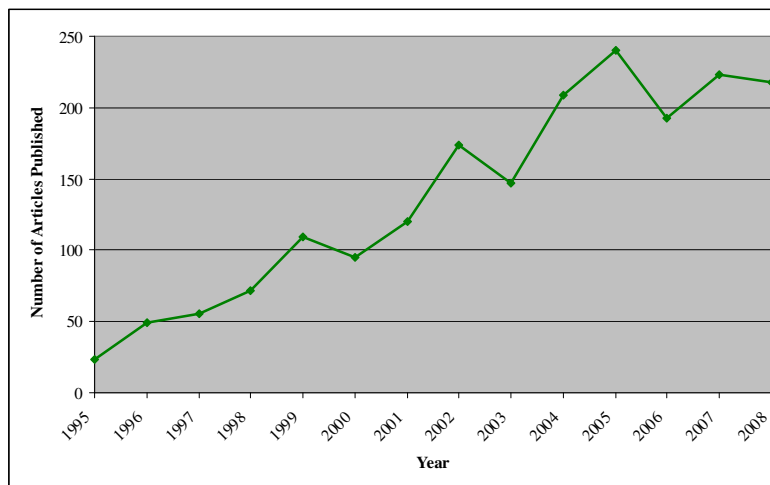
The terms *distance learning*, *e-learning*, and *online education* encompass a wide variety of course types and instructional methods. We will use these terms interchangeably throughout this manuscript. *Web-enhanced* courses are essentially traditional, face-to-face courses which use the World Wide Web to delivery some content, assignments, grades, etc. *Blended*

learning courses typically deliver a substantial percentage of course content electronically and often use online discussions, chats, etc. in addition to face-to-face classroom meetings. *Online courses* are those in which the vast majority of content is delivered electronically and in which instructor-student and student-student interactions are predominantly online.

In recent years, there has been an explosion of scholarly research on various aspects of e-learning, mirroring the growth in online education programs. A search of the ABI/INFORM database of academic research reveals that the number of publications per year on distance learning increased by more than a factor of 10 between 1995 and 2005 (based on a search of peer-reviewed journal articles using the key words “e-learning,” “distance learning,” and “online education”). Figure 1 illustrates the publication trend over the years 1995 to 2008. The pattern of publications parallels the trend in online course offerings, which experienced a dramatic increase between 2003 and 2007 (Allen and Seaman, 2008).

The research related to distance and e-learning is vast, and we do not attempt an exhaustive review here. Rather, we provide an overview of the types of papers and highlight the need for more guidance for instructors. This existing research can be grouped into three main

FIGURE 1: SCHOLARLY PUBLICATIONS ON DISTANCE AND E-LEARNING OVER TIME



categories: effectiveness of online education, case studies of e-learning in specific environments, and the evolution of distance learning in different areas.

The first, and by far the biggest, category of research explores the efficacy of online education. The fundamental question being examined is: Is online learning as effective as in-person learning? Wan et al. (2008) provide a research model to help explain factors that impact learning effectiveness and satisfaction along with a useful set of questions for further research which they define as technology-mediated learning. Piccoli et al. (2001) found that web-based instruction was just as effective as in-person instruction, although students found the web-based approach less satisfying. Zhang et al. (2004) report that distance learning actually offers advantages over traditional classroom instruction: the course delivery is learner-centered and self-paced; there is time and location flexibility; and there is the potential that the course content is available to a global audience. Seal and Przasnyski (2003) tried a number of technologies in an introductory graduate OM class and found that some of the simpler tools such as web-based feedback worked well, but more complex tools such as digital video instructions took a significant amount of time to develop, and their value depended on the individual instructor.

Another question related to e-learning efficacy is: What are the factors that influence the effectiveness of online learning? Eom et al. (2006) use structural equations modeling to analyze data from nearly 400 students at universities in the mid-western U.S. and conclude that online learning may actually be more effective than in-person learning for students with certain learning styles and abilities. Wan et al. (2008) use social cognitive theory to explore the underlying psychology of e-learning; echoing the results of Eom et al. (2006), this research concludes that certain student abilities, such as virtual competence, are closely linked to e-learning success.

The second category of research discusses distance learning in specific contexts. For example, Netteland et al. (2007) and Unneberg (2007) discuss the benefits and challenges of e-learning in large organizations. Other research in this area focuses on distance learning in a particular industry or application. Berke and Wiseman (2003) examine the use of e-learning in the field of nursing. Keh et al. (2008) discuss distance learning in the context of military education. Scalise et al. (2007) report on the emerging field of “adaptive content” in which the content delivered to students changes depending on assessment results of earlier learning. All of these papers provide case studies, which can serve as useful — but general — guides for implementing online education. One article, Coppola et al. (2002), does look at how professors changed their behavior when moving into the virtual environment: more precision was identified in their teaching materials; more student monitoring was required; and they tended to become the facilitators of the multiple conversations taking place between them and their students.

The final research category addresses the evolution of distance education in different regions. As mentioned previously, e-learning has become firmly established in the U.S. Not surprisingly, other countries and regions are experiencing similar growth in the use of distance learning technology. Chen and Guo (2005) report on the evolution of e-learning in China. Hussin et al. (2009) describe developments in online education in Malaysia. Joshi et al. (2002) discuss e-learning trends in India. Bennett (2002) addresses distance learning in Scotland. These are only a few of the many examples of how e-learning is expanding all over the world and beyond the traditional university setting.

While it is obviously important to study the effectiveness, mechanisms, benefits, and challenges of e-learning, these research studies offer little guidance to instructors. In many universities, online programs are evolving

quickly. This state of flux is driven by changes in enrollment patterns as well as the development (and maturation) of new technologies. This environment offers exciting opportunities for students as well as instructors. However, along with these opportunities come risks. One of the biggest risks is the amount of time required by faculty when incorporating distance learning. Indeed, a recent survey of more than 10,000 faculty found that the additional time and effort required to develop and teach online courses was the primary obstacle keeping faculty from engaging in distance education (APLU, 2009). Missteps can multiply the amount of effort and frustration involved. Knowledge sharing and research is critical. However, little or no research has been done on which tools and techniques are the most useful from the instructor's perspective. In the next section, we begin to fill this gap by reviewing some of the many technologies available and then offering guidance about when and how to use them.

III. ONLINE TOOLS FOR TEACHING OPERATIONS MANAGEMENT

Instructors who are interested in online education are faced with an overwhelming number of choices related to how much content to deliver electronically, what types of technologies to use, and how much to rely on "off-the-shelf" versus custom-built solutions. To help instructors navigate the vast array of options, we provide a detailed review of some of the most popular tools. In addition, we identify specific examples and/or concepts for which the tools are particularly well suited.

Table 1 lists many of the tools in use today and, with the following paragraphs, provides justification for why specific tools are useful or not, for graduate or undergraduate classes. While the analysis is useful across disciplines, the experience is based on our collective experience teaching OM classes over many years in a business school at a mid-sized public university.

3.1. Traditional Online Tools

First, let us examine the most common tools found in all distance learning platforms: email, chat, and discussion forums.

Email

We have found email to be useful for general announcements and logistical details, for both graduate and undergraduate students. When multiple students have the same question, other tools, such as discussion forums and chats, may be more useful as discussed below.

Discussion Forums

Discussion forums are useful for class discussions. It is useful to break the forum into two sections, one for logistical questions and another area for content discussion. At the graduate level, a discussion of an article entitled "The Psychology of Waiting Lines" (Maister, 2009) was very effective. The article presents several propositions about different facets of waiting lines. Students respond whether they agree or disagree with the individual facets and whether they agree or disagree with other students, making a rich, multiple-level discussion.

At the undergraduate level, discussions are best started and monitored by the professor. For example, when students were asked the question whether businesses should be expanding capacity or reducing capacity in today's market, the students responded mostly to the instructor, but occasionally to each other. To encourage participation, a small portion of each student's grade was tied to the use of the discussion forum. A simple rubric (O, V, I; for Outstanding, Very Good, Needs Improvement) was used to evaluate students posts. Posting evaluations was not necessary for the graduate students.

Chat

Chat is used extensively at our institutions. We have found that "thinking on one's feet" during synchronous chat discussions

models real-world business decision making well. For example, the graduate OM class is very case oriented, and chat allows for an ongoing class discussion of major issues in the case. For undergraduates, chat is useful for the explanation

of course concepts, especially those which are qualitative versus quantitative in nature. For example, we discuss the differences between traditional inventory management

TABLE 1: SUGGESTED APPROPRIATE USE OF DISTANCE EDUCATION TECHNOLOGIES IN OM CLASSES

<i>Tool</i>	<i>Stage of Development (O=old; N-New; E=Emerging)</i>	<i>OM example</i>	<i>Useful in Graduate</i>	<i>Useful in Undergraduate</i>
Email	O	Announcements	Yes	Yes
Discussion forum	O	Queuing theory article discussion graduate; Current capacity undergraduate	Yes	Yes
Chat	O	Explanation of JIT vs. JIC Inventory Management undergraduate, Capacity Management case graduate	Yes	Yes
Group Chat	O	Lean production discussion	Yes	No
Wiki	N	Process improvement model	Yes	No
Assessment tools	O	Quiz on forecasting to show understanding	No	Yes
Online collaboration tool (here, Wimba)	O	Case discussion: Capacity Management	Yes	No
Blog	N	Comments on reading (Goal grad class, current events undergrad)	Yes	Yes
Micro-blog (e.g. Twitter)	E	Team members communicating, faculty contact the week before an exam	Not yet	Not yet
Podcast	N	TQM explanation	Yes	Yes
Video Podcast	N	Reexamine issue presented in class; process analysis	No	Yes
Video capture technology	N	Explanation of the LP transportation method	Possibly	Yes
Video	N	Use of SPC methodology in service industry; search for videos on outsourcing	Yes/No	Yes
Simulation	O	Capacity management: buying machinery	Yes/No	Yes
Virtual world (Second Life)	E	Not used, too time intensive	Not yet	Not yet
Proprietary vs. open source system (WebCT vs. NextEd)	N	Speaker series: Lean services (do not need to be registered in NextEd)	Yes: open source and proprietary	No: proprietary only

strategy (just in case) versus newer lean inventory strategy (just in time). Assuming the instructor has good typing skills, this is easily accomplished in the chat, allowing for students to “raise their hands” if they have any questions.

Group Chat

A special case of chat is group chat. This, in essence, is a chat area dedicated to a small group. The group can discuss assignment issues in private, without other students being able to see or observe. Typically the instructor also has access to the area to observe, make sure everyone is participating, and if necessary provide comments. In the graduate class, this worked well for case analysis. Students were assigned cases, for example a lean production case about Toyota, where they were to write up a group case analysis. Attachments could be shared and comments/discussion carried on to develop a group consensus.

3.2. Newer Web 2.0 Tools for Distance Learning

Next we focus on some of the newer Web 2.0 tools which may or may not be incorporated into current learning management systems — wikis, blogs, Wimba collaboration tools, and screen capture technology. In general, graduate students demonstrate more independence and discipline when using the tools. Thus, wikis and Wimba, which require students to exhibit some restraint to stay on target, are more suited for graduate students.

Wikis

“A wiki is a Web site that allows users to add and update content on the site using their own Web browser” (www.techterms.com/definition/wiki, 2009), and Wikipedia (www.wikipedia.org) is perhaps the best known example. In a graduate class, a wiki was used successfully on a process improvement model. The instructor laid out the current process and students were asked to improve upon the process. All changes were recorded on the

wiki and the authoring was documented. This allowed for an incremental improvement process to be documented, and if someone did not agree with an improvement, they could change the process back, and insert an explanation why. This provided a useful tool for incorporating multiple perspectives. In another example, graduate virtual teams from two different universities in different countries used a wiki to develop thoughts and document resources to support a research paper the group was doing. Organizing the wiki became the outline for the papers. Overall, from our experience, undergraduates were not disciplined enough to use the tool. We also caution about assigning individual wikis. The administrative overhead and evaluation can become excessive.

Wimba

Wimba (www.wimba.com) is a collaborative online learning tool that includes a chat facility, white space for displaying PowerPoint slides, audio, video, and even the ability to “put up your hand” if you want to cut in on the conversation (necessary if you have 20 or 30 people in the session). It is a useful and inexpensive tool designed for the academic market to enrich the typical text-based chat. It can also be useful to allow those not registered for a course to participate, such as an outside speaker. As with wikis, in general, undergraduates are not disciplined enough to use the tool. That is, they often “talk for the sake of talking,” or alternatively, stay “silent” instead of participating. Graduates, on the other hand, typically use the tool effectively. We have found the most benefit in a case discussion where the instructor is leading the conversation. He/she guides the discussion, makes clarifications, and asks leading questions. Since they are involved in a heavy percentage of the conversation, say 30–40%, they can talk faster than they could type, speeding up and enriching the conversation.

Blogs

Blogs are useful for both graduate and undergraduate classes. In the graduate operations class, the class is assigned *The Goal* (Goldratt, 1992), which explains the theory of constraints and capacity management through a story format. Students are encouraged to post any thoughts or perspectives they have on this book throughout the semester. Over half the students were actively involved, posting on average two ideas per week. In the undergraduate class, the instructor must be more involved. Students were asked to post “current events” postings related to operations topics discussed in class, and to comment on postings of others. This worked fairly well, although the instructor had to get deeply involved in indicating which postings were appropriate and which were not relevant (for example, complaints about an exam). Thus, the blog had to be monitored to keep it on target.

Micro-Blog (Twitter)

A micro-blog, Twitter (www.twitter.com) being the most famous one, is a way to quickly send someone a small amount of information. Tweets, or messages, are limited to 140 characters. Twitter is very popular as a social networking tool for individuals and, increasingly, companies. Its use in the classroom has been more limited. However, Twitter can help a team get to know each other — both academically and socially. This can be particularly useful for virtual teams. Virtual teams often suffer trust issues from not being able to see each other and interact in traditional ways. The kind of “What are you doing?” tweets shared back and forth can help. Also, in a time of pressure, say the week before the presentation is due, Twitter can be a useful way for a team to stay connected and coordinated.

3.3. More Advanced Web 2.0 Tools

Now we focus on some more advanced tools which are not typically present in learning management systems. Specifically, we look at

the appropriateness of audio podcasts, video podcasts, and screen capture technology.

Audio Podcasts

An audio podcast is an “audio broadcast that has been converted to an MP3 file or other audio file format for playback in a digital music player. Although many podcasts are played in a regular computer, the original idea was to listen on a portable device” (www.pcmag.com/encyclopedia_term/0,2542,t=podcast&i=49433,0.0.asp). Audio podcasts worked well when explaining qualitative information, which did not require pictures, PowerPoint slides, or other forms of visualization. For example, a review of total quality management, and its key principles worked well in both undergraduate and graduate classes. This fits well into most student’s lifestyle of multi-tasking where they can pop the MP3 ear phones in while they are walking around, cooking dinner, etc. Most students now own MP3 players, and some actually enjoyed listening to “current events” as well as lecture material.

Video Podcasts

Video podcasts are similar to audio podcasts but also include images and/or video. For students, video podcasts were generally seen as less useful than audio podcasts. This is primarily because of the need to stop multi-tasking and, if the charts or graphs are detailed at all, view them on a device with a larger screen than an MP3 player, like a computer. In our experience, only a small percentage of undergraduates liked listening and viewing the podcasts as an alternative to reviewing lecture notes. One successful example of where this could be used is showing graphs of the outcomes of different forecasting methods. Another useful application of video podcasts can be as a way for students to present their work. As an example, one distance learning class was required, as part of a group research project, to develop a written executive summary, a PowerPoint presentation, and a video podcast of their results. The podcast was a very effective way for the students to take

the PowerPoint slides to a whole different level by adding an audio track and interspersing pictures or videos where appropriate.

Screen Capture Technology

Screen capture technology, such as Camtasia software, was useful primarily for undergraduates. Its value came in presenting “how to” tutorials prior to class. In the undergraduate class, where a production simulation was used, the instructors created a short presentation which walked students through accessing the simulation, what information was presented on the various screens, and what actions different icons or pull down menus presented. Some instructors have “captured” an entire two-hour lecture, but it is our view that unless a time line is included, students will not be able to watch the entire presentation. Putting in a time line or editing the captured video is a very time consuming task, requiring on the order of five hours for every hour of video captured. Because graduate students are less likely to need “how to” types of information, screen capture technology is not recommended for them.

3.4. Web 2.0 Tools That Emulate Traditional Class Delivery

Finally, we discuss tools which emulate traditional class delivery — specifically, the use of online videos and simulations. These are both recommended for undergraduates and, to a lesser extent, graduate students. These tools can be used the same way as in a traditional class, adding great value.

Online Videos

There has been an explosion of online videos available on the Internet over the last few years through web video sharing sites. As an indication of the popularity of online videos, “Internet viewers have viewed 14.8 billion online videos in January 2009 alone” (YouTube, 2009). YouTube (www.youtube.com) is the most popular example, with millions of videos posted ranging from playful to serious — including

many related to business and operations management. In addition, textbook sites have links to company specific sites and videos which enhance student understanding.

As one assignment example used by us, textbook and supplemental readings on outsourcing were updated and brought to life through the use of online videos. Undergraduate students were asked to review a set of online videos about outsourcing and present one to class that supported or expanded the materials already covered. In this way, apropos to Web 2.0 learning, students were able to contribute their own content to the discussion of a topic. Graduate students are more likely to have had professional job experience, thus the tools will not have as large an impact.

Simulations

Many simulations are now web based, making them equally accessible and acceptable in both traditional and distance learning classes. One simulation, Littlefield Technologies, is a web-based factory (www.responsive.net, 2008). Students are put in teams and have to make capacity management and production scheduling decisions. It has been used in a traditional class, but would fit equally as well in an online class. Discussion forums and group chat areas would be good tools for the groups to use in conjunction with the simulations.

Virtual Reality

The final Web 2.0 tool we looked at are virtual reality tools, in this case Second Life. These tools have the potential to create virtual factories or virtual stores. In many ways, given the relative inexperience of the undergraduate students, virtual worlds can expose them to environments they have never seen — e.g., a factory floor, an automated warehouse, etc. However, the time to master the systems from both the student and the instructor perspective is way too long to be of much value in current classes. If instructors have the interest and time, they could create virtual worlds which students

could work with, but as indicated previously, the time commitment, currently, is huge, and probably not a productive use of a faculty's time.

Learning Management Systems

Finally, there is the issue of the platform to deliver online courses. Proprietary learning management systems (LMSs), such as Blackboard, have become richer in recent years, adding more features, many of them listed above. The major upside is that they have good technical support, in case there are problems in functionality. The major downside is their cost. Another difficulty is accessibility, as those who are not registered in the class are denied access, making it cumbersome, for example, to add a guest speaker or to connect students from different schools in a virtual team. In contrast, open source software, such as NextEd or Moodle, does not require a license, thus making it more accessible, especially to students in the developing world. Also, students or other speakers could be added very easily. The major disadvantage of these open source packages corresponds to the major advantage of the proprietary software, that is, technical difficulties would not necessarily be fixed, and you would need to supply your own support staff.

IV. CONCLUSIONS

Distance and e-learning are a fact of life in the U.S. and elsewhere. The growth rate of online programs far exceeds that of traditional, in-person programs. As these programs have evolved, so too has the facilitating technology. Simple learning management systems such as Blackboard, once the state of the art, are now viewed as standard equipment — like textbooks and course packs. The development of Web 2.0 tools has created amazing opportunities to enhance the learning process. Along with these opportunities, however, also come risks. All too often, instructors are left to their own devices to decide which technologies to use, how to make

the technology work, and which technology is best for a particular application.

Previous research on distance and e-learning has focused on the student perspective; specifically, is online education as effective as classroom instruction? Today, the clear consensus is that online education is an effective means for many forms of classroom instruction — with appealing cost points for revenue-starved institutions. However, the “devil is in the details” where faculty are left with the challenge of making online education work. In the paper, we take the instructor perspective and present a review of current and traditional Web 2.0 tools available for online education. Based on more than 20 years' of collective online teaching experience, we discuss the pros and cons of various tools and provide guidance about which tools to use, focusing on their application in Operations Management related classes.

While this paper represents an important first step in exploring the instructor perspective of distance and e-learning, many opportunities exist for future research. First, to generalize the results presented in this paper, a survey of operations instructors' preferences would be useful. Which technologies are most used and why? Second, an empirical examination linking specific technologies to particular learning objectives would be valuable. What is the best technology to get a particular point (or concept) across? While experience is valuable, a more rigorous examination of these questions would be of value. It is our hope that this paper will serve as a primer on e-learning tools and give instructors who are just getting started or those who are looking to take their online efforts to the next level a head start in this exciting area.

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