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A Hybrid Push-Pull Model to Support Learning: An Empirical Evaluation

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Abstract

This paper utilizes two Internet technologies—traditional web-based “pull” technology and emerging “push” technology—to support learning beyond classroom environment through time and space. It describes a generic model that can be adapted to the specific requirements of different courses. We developed two systems based on the model for two courses. One hundred and forty students in six classes evaluated the systems. The evaluation suggests that the systems facilitated learning by providing critical course information in timely manner and in usable formats. The systems were user friendly and increased productivity and convenience of the students. Overall, the students found the systems useful and satisfactory.

Introduction and Background

Many instructors put course schedule, lecture notes and other teaching material on the web to support classroom-based learning. Recently, an argument is made that the practice has not achieved expected objectives (Young, 1998; Noble, 1998). A close review suggests that there are multiple reasons for the sub-optimal results:

- Most course web sites are passive. They lack the interactivity which is crucial in some learning activities such as group discussion, case study analysis, continuing unfinished class discussion, asking questions and immediately receiving answers, clarifying what will be studied in the next class and receiving regular instructor feedback.
- When new material is uploaded or old material is revised, most students do not know about it unless they regularly check the course web site. Often critical, time-sensitive material is not reviewed by every student. In addition, the instructor is never sure whether all students reviewed the material.
- Not all material is available on the course web sites because many instructors are reluctant to put their intellectual work on the web due to security and possible violation of their intellectual property rights. Or simply they do not have the skills and tools required in HTML/web site design.

These reasons are related to the inherent limitations of the web. The web is based on unsecured, static, *pull* technology. Under the *pull* format, content is not available to an intended recipient unless the recipient specifically requests it. For example, web browser does not get us news unless we go to a news web site. However, a new Internet technology—*push* technology—has recently emerged to provide solutions for some limitations of *pull* technology. *Push* technology is "a client software that lets Internet users customize delivery of information directly to their desktops from a variety of sources" (Levitt, 1997). It evolved as an alternative to the pull-based web from PointCast, Inc.'s personalized broadcasting technology in 1996. In the last three years, it has gone through the full length of the hype curve. By the third quarter of 1997, it rose to the peak of the hype curve with inflated expectations (GartnerGroup, 1997). However, soon after it fell into the trough of disillusion due to its limitations. Recently, it has returned more mature with clear understanding and reasonable expectations.

Despite its apparent failure, push technology has several advantages over pull technology. Push technology allows secure delivery of dynamic, multi-media content in real time to a pre-defined, intended group of recipients even without requiring them to open a web browser. Push technology can be used to deliver time-sensitive information such as news, current inventory level, changes in prices and new product offering more efficiently and effectively. Push technology allows personalization of message or mass customization where a large group of receivers can receive system generated but customized information. Push technology allows delivery of information only to the intended recipients. This increases security and reduces risk of exposing sensitive business information to others. Push technology also provides capabilities to ensure that the receiver has received the information and at least viewed it. Push technology can also be used to automatically distribute new applications and data files.

However, push technology has some limitations such as network clogging and information overload, which have led to its downfall and kept the technology from being a dominant force on the Internet (Hayes, 1997; Mosley-Matchett, 1997; Pflung, 1997). This paper takes an intermediate approach by utilizing a hybrid model to support learning. The model is derived from a framework proposed by Malhotra, Gosain and Lee (1997) for information delivery and acquisition systems design. The model identifies and integrates useful features of both push and pull technologies to support learning. Furthermore, the paper evaluates the effectiveness of two systems developed based the model in supporting learning.

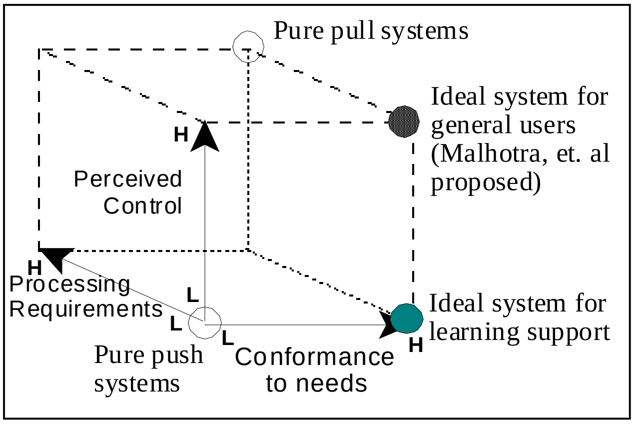

Figure 1: The Hybrid Model

The Hybrid Model

Many researchers suggest that best results can be achieved by blending Internet technologies in one solution (Aragon, 1997; Hibbard, 1997; Malhotra, et al., 1997; Rivlin, 1997). We follow the lead and utilize a hybrid model for learning support as shown in Figure 1. The model is derived from a model proposed by Malhotra, Gosain and Lee (1997). It maps different types of systems on three dimensions of the information recipient perspective: Perceived control, conformance to needs and information processing requirements.

Perceived control refers to the perception of the user about who initiates and controls the information delivery process—the user himself or the system. It is an important variable in system usage. It is high when the user initiates the information delivery process and is low when the system initiates the process. In a pure pull system, perceived control is high because the user initiates the process by deciding when and from where to receive the information. In a pure push system, perceived control is low as the system initiates the process by identifying the change in the available information. In an ideal system for general users perceived control should be high (Malhotra, et al., 1997). While, in the case of learning support, the instructor should controlled the process through the system instead of by the students (users) for two reasons. First, in a structured course, what information the students should receive and when can be determined better by the instructor of the course. Second, when new information becomes available, it must immediately reach the students. However, taking the control away from the students may lead to dissatisfaction and lower utilization of the system by the students. To avoid this, the instructor should encourage and/or require the students to use the system. In addition, the system must add real value and increase overall effectiveness of the education process. The system should be designed in such a way that, although the actual control is with the instructor, the students may perceive that they are in control for which temporal transitivity can be used (Malhotra, et al., 1997).

Conformance to needs refers to the extent to which the delivered information matches the needs of the information recipient. In a pure pull system, the conformance to needs is high because the user determines what he or she wants by clicking on a specific hyperlink. In a pure push system, the conformance to needs is often low because the system determines what the user should receive. In an ideal learning support system, the conformance to needs should be high. The instructor should determine the content in line with the objectives of the course and the students' knowledge level. Efforts should be made to increase conformance to needs by having the users determine their profiles which can be used by the system in deciding what content should be sent to whom. In addition, artificial intelligence technologies can be used to filter out unnecessary information.

Information processing requirements refer to the amount of information the user needs to process to get the right information. The amount depends on the complexity and the equivocality of the information (Daft and Huber, 1987). In a pure pull system, the processing requirements are high because the user has to search through many web sites to find the right information. In a pure push system, the processing requirements are low because the right information is automatically delivered to the user by the system. In an ideal learning support system, the processing requirements should be low by automating delivery of all course information without student asking for it.

Evaluation

To evaluate the hybrid model, two fully operational systems, System A and System B, were developed. The architecture and features of the systems are described in detail in a paper presented at the 1998 Americas Conference on Information Systems (http://www.isworld.org/ais.ac.98/proceedings/track30/verma.pdf). System A supports a simulation gaming course that requires heavy interactions including communication and transfer of files between the course instructor, individual students and student teams, which are working as competing firms in a simulated business environment. System B supports a structured business course (such as CIS, management science, and statistics) which requires less interaction but requires the students to spend considerable time in pre-class and post-class activities. Thirty-seven undergraduate students in two classes used System A. One hundred and three undergraduate students in four classes used System B. Demographics data suggests that the samples are representatives of the population of junior and senior undergraduate students at urban business schools in large cities.

A questionnaire was used to measure overall learning support. The support was measured on four

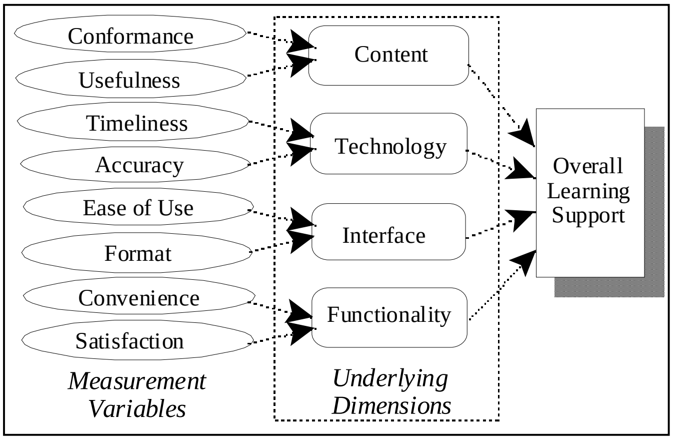

Figure 2: The Evaluation Model

underlying dimensions related to content, technology, interface, and functionality aspects of the system (Figure 2). Each dimension has two variables as shown in the figure. The questionnaire was designed from a comprehensive review of previous studies related to the assessment of systems on different dimensions. (Aldag and Power, 1986; Doll and Torkzadeh, 1988; Kettinger and Lee, 1994; King and Premkumar, 1990; Mahmood and Medewitz, 1985; Raymond, 1987; Subramanian, 1994). The questionnaire contained total twenty-five questions. Each question was a statement on which the students were asked to rate the system they used on a Likert-type scale of 7 points where 1 being strongly disagree and 7 being strongly agree. The hypotheses are that the systems provide above average support for learning from the students' perspectives. Above average support is determined by a statistically significant difference between the average score on each variable and value four, the average value on the scale.

Results and Discussion

A correlation analysis and a factor analysis were performed to evaluate construct validity of the questionnaire. The correction analysis showed all but one (p=.001) correlation are significant (p<.001). The factor analysis showed a reasonable alignment of variables along the underlying dimensions. Reliability of the questionnaire was evaluated by Cronbach Alpha (Cronbach, 1951). The alpha value of .7 or above is preferred for a basic exploratory research (Nunnally, 1978). The alpha value is above .7 on all variables except one for which it is close enough to not cause much concern (Table 1). Table 1 further shows the average scores and the standard deviations of System A, System B and both combined (Overall) on the dimensions described by the evaluation model. All average values are more than the average value of the scale (four). The table also shows the result of the significant tests (t-values and p-values) conducted to confirm the hypotheses. Having calculated t-values above t-critical (1.65 at α=0.05) and p-values below .001, the tests indicate both systems provided above average support on all dimensions. Thus, we can conclude that the systems supported learning.

Table 1: The Results

Underlying Dimensions	**Variable**	Cronbach **Alpha**	**System A**		**System B**		**Overall**		**Significance**	
			Avg.†	**Std.**	**Avg.**†	**Std.**	**Avg.**†	**Std.**	**t**	**p<**
Content	Conformance	.874	6.35	.863	5.64	.908	5.83	.947	22.9	.000
	Usefulness	.939	6.27	.863	5.41	1.32	5.64	1.27	15.2	.000
Technology	Timeliness	.732	6.39	.714	5.91	.775	6.04	.785	30.7	.000
	Accuracy	.694	6.45	.677	6.12	.813	6.21	.793	32.9	.000
Interface	Ease of Use	.804	6.42	.589	6.26	.612	6.30	.608	44.8	.000
	Format	.740	6.48	.705	6.14	.681	6.23	.701	37.6	.000
Functionality	Convenience	.766	6.38	.704	6.04	.670	6.13	.693	36.4	.000
	Satisfaction	NA*	6.41	.798	6.10	.902	6.18	.884	29.2	.000

* Only one question was asked that measured overall satisfaction with the system.
† On the scales of 1 to 7 where 1 being strongly disagree and 7 being strongly agree.

Conclusion

This research shows that a combination of push and pull technologies supports learning. This was an exploratory study. Although the results indicate that the systems supported learning, we cannot and do not claim that the systems improved learning. For such a conclusion, there is a need to conduct a controlled experiment with the control group using a pure pull (a generic course web site) or push system and the experimental group using a hybrid system. The experiment should measure the effects of the two treatments on the variables related to improvement in learning. In addition, other useful technologies and concepts can be incorporated in this model to improve support for learning. An example is intelligent agent technology. Intelligent agents can adapt support to the knowledge level of the users by identifying working patterns and learning needs of the users.

The references, the questionnaire and an expanded version of this paper are available at http://www.ite.poly.edu/people/mparikh/ in "Research" link.