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Aligning IT Skills Training With Online Asynchronous Learning Multimedia Technologies

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Abstract

With so many different content delivery methods and available instructional technologies, developing the ideal environmental learning profile of IT skills, training tasks and online asynchronous learning (OAL) multimedia technologies is critical. By understanding the most effective OAL multimedia technologies to apply and in what context, the alignment will help organizations improve learning outcomes. The task/technology fit theory is replicated in the context of an OAL environment to examine multimedia technologies from a social context where end users adopt them to improve learning performance.

Keywords: e-learning, task-technology fit, social presence, behavioral modeling, multi-media technologies

1. INTRODUCTION

This study investigates the fit between technology and task from the organizational (Perrow, 1967) or a group process perspective (McGrath, 1984). It focuses on software training tasks in an online asynchronous learning (OAL) environment. As described in other studies, the task-technology fit is an important predictor for group (Zigurs and Buckland, 1998) and individual (Goodhue and Thompson, 1995) learning performance. We deduce with the same logic the task-technology fit can also be used to predict expectation about a trainee's learning performance in an OAL environment. Online training is being leveraged to train users located across wide geographical distances. The asynchronous delivery method of the material is predicted to grow exponentially.

Within the corporate setting, online software training accounts for about 50 percent of the online learning market's growth, according to WR Hambrecht & Co., and International Data Corporation (IDC) (Sauer, 2001). Suntrust Equitable has projected that the online software training market will grow to $6 billion by the year 2004, up from its 1998 level of $400 million, a 47 percent compounded annual growth rate (CAGR). The worldwide corporate online learning market may grow to $24 billion ($18 billion in the U.S.) by 2006 with a compound annual growth rate of 35.6 percent (IDC, 2002). There exists a growing population of students who either financially or logistically have difficulty meeting instructors and classmates face to face on campus. In addition, new incoming students tend to be more computer literate and experienced with computer applications. To reflect these demographic changes, educational institutions and businesses are increasing their training budgets for students and employees respectively. With the growing number of these students and the increasing training budgets, the online learning and training market has blossomed. There is motivation and

practical reasons in the online educational industry to research and investigate the effectiveness of OAL environment as it relates to the specific type of task. A constructive surrogate to evaluate the effectiveness is the task-technology fit theory.

However, task types defined by the organizational and group process perspectives may not be applicable to tasks in the field of software training. There are a number of different training method approaches which have been established to deliver content. Based on their learning style, some methods are more effective than others. After careful analysis, one of the training methods will be selected as the means of delivering the multimedia technologies in an OAL environment. A taxonomy to classify the OAL multimedia technologies by the elements of social presence and interactivity level has been developed. Different perspectives of fit will also be discussed and assessed by their applicability to the context of software training. By integrating these complementary streams of research, this study proposes a task-technology fit framework which more accurately predicts the success of OAL programs.

2. BACKGROUND

2.1 IT Transfer Tasks

We focus on the IT skills-related tasks that are generally classified as near-transfer and far-transfer tasks. It is imperative to understand the knowledge transfer process in order to know the distinction among the software training tasks. Knowledge transfer is the application of acquired skills and knowledge into different situations. Unless the transferring process occurs, learning has little value. The applied situations could be similar or novel to the learning situation. Depending on the situation, knowledge transfer can take place in different formats. In general, there are different types of knowledge transfer, such as positive versus negative transfer, specific versus general transfer, lateral versus vertical transfer, and near versus far transfer. A positive learning experience can be enhanced via analogy, informed instruction (Paris, Cross and Lipson, 1984), tutorial (Morris, Shaw & Perney, 1990), etc. Learning effectiveness can be improved by triggering positive learning and mitigating negative learning experiences. Specific transfer refers to the extension and association of habit and skills; general transfer refers to the transfer of principles and attitudes (Bruner, 1996). Lateral learning is to apply one domain of knowledge to another domain; the vertical transfer of learning is analytical and sequential (Gagne, 1992).

Salomon & Perkins (1988) argued knowledge exhibits different degrees of transfer. The effectiveness of near-transfer learning depends on the learner's ability to solve problems similar to those encountered in the context of learning. For instance, learning how to add two digit numbers allows learners to add three digit numbers. Near-transfer learning occurs in two similar situations and at a lower level. Therefore, the level of learning is more easily acquired and applied. In contrast, applying the acquired skills and knowledge in two dissimilar and sometimes novel situations is much harder to achieve. As an example, a table tennis player can apply his skills of playing pinball to playing tennis. Although both sports look similar on the surface, the techniques to control pin balls and tennis balls are very different. The learning transfer is much harder to be acquired and retained. Therefore, the transfer is defined as far-transfer learning. The near-transfer and far-transfer of knowledge seem to be the most widely used measures of learning outcomes in the field of information technology since learners must utilize the knowledge learned in a computing environment. The study adopted the near-transfer and far-transfer measures of learning outcomes for this information technology related field experiment.

2.2 Training Methods

Research has shown there are three primary types of software training approaches: Exploration-Based (EB), Instruction-based (IB) and Behavior Modeling (BM) (Simon, Grover, Teng and Whitcomb, 1996). In the EB method, the assumption is made that much of learning is "a matter of rearranging or transforming evidence in such a way that one is enabled to go beyond the evidence so reassembled to additional new insights" (Bruner, 1966, p.22). EB involves an inductive process through which individuals learn general concepts by trying to solve specific tasks (Taba, 1963). In the IB method, "the entire content of what is to be learned is presented to the learner in the final form" (Ausubel, 1963, p16). IB is deductive and programmed, with low trainee control and a focus on software features (Davis and Davis, 1990). The BM method is in some ways a hybrid of EB and IB, and is based on having trainees model the behaviors of their trainer (Simon et al., 1996).

When assessing the applicability of these three training methods in an OAL environment, researchers must bear in mind some of key elements of software training using different multimedia technologies may be lost migrating to an OAL environment. One difference is OAL offers reduced opportunities for interactions between the trainers and trainees. The beneficial affects of

trainer and trainee direct social interactions typical in Face-to-Face (F2F) training is lost. Animation, videotapes, scripted transcription or other technology-based delivery method can be substituted for live lectures. With these content delivery differences, the features which distinguish BM from EB and IB may perhaps be less evident in an OAL situation.

Unlike what is common in synchronous training environments, OAL does not provide a high level of trainer monitoring of trainees. This may lead to increased levels of distraction among trainees. Trainees in the OAL environment are able to attend to matters other than their training to a greater extent than in class F2F or technology delivered lessons. The high amount of flexibility and freedom found in an EB learning environment often causes a high amount of user distraction. Since EB is more trainee controlled than other methods, it may raise the likelihood that trainees will not practice the self-discipline required to stay on task. If trainees do not stay on task, they are more likely to not perform well in training and result in lower satisfaction.

Another difference in OAL is in the delivery of materials to trainees. The teaching content may be less tailored to their interests than those provided in video, scripted and animation-based systems. It is also more likely for OAL trainees to become disinterested by the training materials. This issue is compounded even more when the IB training method is used. IB training presents materials that the trainer chooses to display, at a pace the trainer chooses. Since there is little or no feedback to the trainer regarding trainees' reactions to the materials, it is more likely that trainees will find that they are not interested in the materials. If trainees are bored, they are less likely to perform well or have positive reactions to their training experiences. Bostrom, Olfman and Sein (1990) suggest research on the matching of learning style and training method. Since the focus of this study is OAL multimedia technology, the BM approach is adopted to mitigate the influence of learning style on learning outcomes. Three OAL multimedia technologies will be used to assess their profile fit with different knowledge transfer tasks.

2.3 OAL Multimedia Technologies

The Information Age has introduced a number of new enabling technologies which allow people ubiquitous access to data. Using the public access networks, the Internet has allowed organizations to delivery online training material through new mediums. Synchronous learning and training is normally accomplished using animation training. It requires thorough control of the environment including the locale, schedule, time, people, class size, video and audio equipment. These factors reduces the possibility of reaching large numbers of students at a given time and place. Asynchronous learning/training is more individualized. The learning environment, course materials and trainee's availability is flexible allowing the student/trainee to learn at their own pace. Built upon the task/technology theory, this paper chooses three types of multimedia technologies for investigation: animation, transcriptions and videotapes. The goal is to determine (1) the profile fit between these multimedia technologies, on near-transfer and far-transfer tasks, and (2) the actual performance outcomes of the participants in assimilating new information using these different delivery modes.

2.3.1 Videotape

Short, Williams and Christie (1976) state "communications media vary in their degree of social presence, and the variations are important in determining the way individuals interact" (p.65). Because of "isolation and alienating" factors, social presence may directly affect OAL outcomes (Chang and Lim, 2002) and pedagogical learning processes. In addition, the media perception is "subjective and socially constructed" (Fulk, Schmitz and Steinfield 1990, p. 121). Enhancing social presence of OAL media can promote subjective values (end user satisfaction) of the media (Gunawardena and Zittle, 1997). With many different environmental factors (bandwidth, audio and video equipment) available for content delivery, it may not be effective, financially or educationally, to maximize the level of social presence in an OAL environment. It is necessary to examine how much an individual's learning outcome can be improved by evaluating the "amount" of social presence necessary. This can help us justify the economic cost of substituting live instruction and more classes with multimedia presentation and fewer classes.

High social presence OAL media is found in stream multimedia, animated websites, whiteboards, and discussion boards. Low social presence OAL media examples include lecture slides, browser links to Internet sites, indexing systems, and announcements. However, the former OAL media may deliver a higher psychophysical presence of discussants (including faculty, guest speakers and students) than the latter OAL media forms. We assert that by choosing higher OAL media to conduct software training the perceived usefulness and learning outcomes of learners can be improved. This perspective has been supported by

most of the researchers in the field of Management Information Systems and Organizational Behavior fields (Kumar and Benbasat, 2002). The study adopts the view to improve the social presence factor in OAL by selecting videotaped course materials to deliver the BM approach (videotaped BM or VBM).

2.3.2 Transcription

One of the great advantages for OAL multimedia learning is its ability for instructors to reach more geographical dispersed users at any time. However, one potential barrier is the control of bandwidth availability to users. In situations where there is a great disparity of bandwidth availability, instructors can either reduce the resolution of videotapes or substitute videotapes with transcripts. By adopting the BM approach, a lower resolution of videotapes may not be well accepted by users because each part of the step-by-step instruction will not be very clear. In contrast, transcription technologies do not need to compromise resolution. They follow predetermined scripts to deliver screen snapshots sequentially. It is very much like drawing pictures in a book and then flipping through the book. Many cartoons were produced in this format. However, the lack of the instructor's facial expressions may weaken the enforcement forces of the social presence factor via the transcription technology. In addition to providing no control for users to interact with OAL systems, transcription technology may be efficient and cost effective to perform near-transfer tasks, but not necessarily the far-transfer tasks. OAL inherently possess less trainer-trainee interaction and social presence. Scripted-based Behavioral Modeling (SBM) transcription technologies provide some capabilities for the modeling of appropriate behavior by trainers while having a higher degree of self-paced control. On the other hand, SBM training approach has less social presence than VBM which may affect outcomes.

2.3.3 Animation

One of major concerns about the effectiveness of OAL is the lack of interactivity between the instructor and learners. The "Interactivity" is defined as "students receiving intrinsic feedback on their actions which relate to the goal of the task." The feedback can be either "explicit" or "implicit." Animation-based feedback can be categorized as the implicit feedback while the best examples of model answers for a given task are often used as explicit feedback. Animation-based implicit feedback can help trigger a learner's cyclic reasoning process, thereby improving their higher order cognitive ability.

Although the pre-recorded multimedia-based course materials may improve learning outcomes, the limitations of user control in OAL may offset the social presence effects. To effectively deliver the personalized online learning experience, OAL needs to embody the interactivity feature into online programs. One way to preserve the interactivity or user control is through the use of animation-based learning. Animation is an effective stimulus in the web environment which affects user's information searching performance, and attracts their attention. Unlike other multimedia-based learning, animation can provide online learners with a higher degree of control over the learning content and processes. In addition, instructors may be able to customize more pertinent information via the animation to improve learning outcomes for online learners. As a result, the personalized learning experience may help online learners, particularly in the OAL environment, to have comparable learning outcomes, or possibly better outcomes than traditional lectures.

In the online learning environment, the length of attention on a particular subject may help users acquire knowledge and retain them in their long term memory. Users employing the animation delivery method need to constantly interact with animated course materials throughout the training session. As the frequency with animations increase, the experience of user involvement will be enhanced. In addition to improving the satisfaction levels, animation-based learning may also significantly improve a users' performance. It is thus reasonable to speculate that over the same training session, animation's impact on learning outcome may be greater than other pedagogical tools with other multimedia-based teaching methods, such as video, audio and virtual reality.

2.4 Profile File of OAL Multimedia

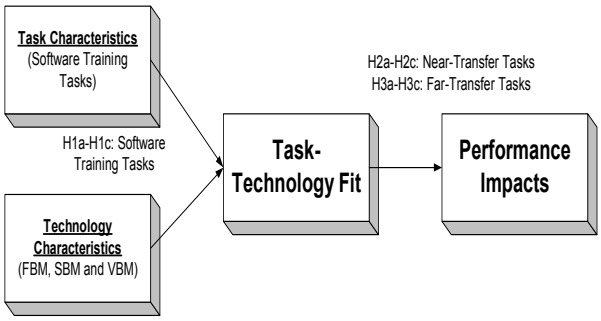
The task/technology theory has been used in assessing the relationship between tasks and dimensions of GSS technology (Zigurs and Buckland, 1998). It is easier to imply the fit between technology and task based on the research findings. Yet, it may be necessary to explicitly define the fit. While the OAL systems (discussion forums, chat rooms, hyperlinks, downloads, multimedia course materials) are widely adopted, their suitability for different tasks remains uncertain. A lack of understanding has made instructors and users tend to choose OAL systems based on their preference. It is important to explicitly define the task-technology fit (Venkatraman, 1989) in the OAL context.

Task-technology theory asserts reserving the flexibility of customizing IT based on tasks for users, facilitators and designers is important (Zigurs and Buckland, 1998). By customizing the technology depending on the type of task, the performance of the individual or group of users can be enhanced. The facilitator and designer of the course material can choose the right technology for the different tasks. Thus, an appropriate alignment of OAL systems and software training tasks may increase the success of OAL programs and the satisfaction levels for trainers and users in the field of IT. Among OAL systems, the OAL multimedia technology is chosen to address the task-technology profile issue.

The term fit can be defined in many ways. In the strategy literature, Venkatraman and Prescott (1990) defined the fit in six different ways as: (1) matching, (2) covariation, (3) gestalts, (4) moderation, (5) mediation and (6) profile deviation. The first three conceptualizations of fit cannot be applied to this study because no criteria can be used to evaluate an individual's performance after learning different OAL animation technologies. In contrast, moderation and mediation perspectives have been assimilated to interpret single independent, mediating, moderating and dependent variables (Zigurs and Buckland, 1998).

The profile fit of software training tasks and OAL multimedia technologies is proposed according to the Task-Technology Fit (TTF) framework (Figure 1). Media with higher social presence may improve the subjective perception of users, thereby encouraging the frequency of usage. This allows online learners to retain the acquired knowledge longer in short term memory (Simon, 1960). As a result, the chance of moving the knowledge into long term memory shall also be increased. In addition, online learners will be more encouraged to practice their acquired knowledge into different situations. This further increases the odds of acquiring knowledge in long term memory. Thus, the media with higher social presence may be a more effective substitute to solve far-transfer tasks.

Figure 1: Theoretical Framework



With a lack of social presence, most OAL systems may be suitable for near-transfer tasks, but not necessary for far-transfer tasks in the field of IT. Videotaped technologies can be effective substitutes to perform far-transfer tasks because they deliver a higher degree of social presence. The transcription content delivery approach may be a less effective alternative technology than videotape because of its lower social presence. The behavior modeling approach delivered in the traditional lecture mode is called animation BM or ABM. Two OAL multimedia technologies – videotaped BM (VBM) and scripted BM (SBM) – were used to deliver the BM approach in this study. Our propositions are summarized in Figure 2.

Figure 2: Profile Fit of Task Categories and Technology Dimensions

	dependent variables	ABM>SBM	ABM>VBM	VBM>SBM
Software Training Tasks	Profile Fit	YES	YES	YES
Near-Transfer Tasks	Actual Performance	YES	YES	NO (VBM=SBM)
Far-Transfer Tasks	Actual Performance	YES	YES	YES

3. HYPOTHESES

The hypotheses listed below correspond to the propositions mentioned before. The list of hypotheses includes (1) three anticipating ABM is a better fit than SBM and VBM, and VBM is a better fit than SBM; and (2) six anticipating that ABM is more effective than SBM and VBM, and VBM is more effective than SBM, with respect to near-transfer and far-transfer tasks.

Profile Fit (H1: software training tasks)

H1a: *The ABM is a better technology fit than the SBM for software training tasks*

H1b: *The ABM is a better technology fit than the VBM for software training tasks*

H1c: *The VBM is not a better technology fit than the SBM for software training tasks*

Actual Performance (H2: near-transfer tasks; H3: far-transfer tasks)

H2a: *Near-transfer tasks should result in a better individual performance when taught using ABM rather than using SBM.*
H2b: *Near-transfer tasks should result in a better individual performance when taught using ABM rather than using VBM.*
H2c: *Near-transfer tasks should result in equivalent individual performance when taught using VBM or SBM.*

H3a: *Far-transfer tasks should result in a better individual performance when taught using ABM rather than using SBM.*
H3b: *Far-transfer tasks should result in a better individual performance when taught using ABM rather than using VBM.*
H3c: *Far-transfer tasks should result in a better individual performance when taught using VBM rather than using SBM.*

4. RESEARCH METHOD

4.1 Experimental Procedures

For the experiment, a total of 38 subjects were randomly assigned based on course enrollment to three treatment conditions: ABM (11), SBM (14) and VBM (13). The researcher provided subjects with an overview of the experiment, as well as a five-minute explanation via analogical instruction (Ahrens and Sankar, 1993) of how to use the training system. Trainees were given another five minutes to complete the pre-test on prior webpage designing knowledge and ten minutes to complete questionnaires. During the experiment, trainees of each group had twenty minutes of training during which they were to learn Microsoft FrontPage 2002™ features and functions.

All subjects were given a near-transfer test and a far-transfer test, plus a questionnaire concerning satisfaction upon completion of their training. The learning outcomes were measured through the following: (1) a ten question multiple-choice quiz. (2) the creation of a MS FrontPage 2002™ . Through these two outcome instruments, the near and far transfer knowledge was measure respectively. The multiple-choice questions were designed to evaluate the trainees' knowledge of Microsoft FrontPage 2002™ commands and features resulting in their near transfer knowledge outcomes. The MS FrontPage 2002™ web site constructions using the functions displayed the users' far transfer knowledge ability. Five minutes were allocated for the quiz while thirty minutes were allocated for the web site design. When answering the questions, trainees were allowed to use whatever online reference resources had been available to them during training.

5. RESULTS

Analysis of variance (ANOVA) was conducted with training method and task-technology fit (TTF) as factors. Training method had three levels: ABM, SBM and VBM. ANOVA is robust for situations where there are a limited number of data points. Table 1 provides descriptive statistics for the dependent variables by experimental treatment. Table 2 summarizes ANOVA results for training methods in terms of learning outcomes. Direction and significance of differences between treatments are indicated. Hypotheses H1a through H1c were not supported suggesting little difference in the alignment of task and multimedia technology. Contrary to our predicted direction, ABM is less suitable than SBM or VBM to assimilate near-transfer knowledge. The SBM and VBM technology are two effective alternatives to the ABM since there is a significant difference in the measure of knowledge near-transfer between ABM and the other two approaches. Hypotheses H2a and 2b are rejected. The SBM and VBM appear to be equally acceptable to subjects for the purpose of assimilating near-transfer knowledge. The SBM may be a more suitable technology than the VBM if there is a choice. This indicates that social presence may be an important factor. Since there is no significant difference, Hypothesis H2c is supported.

Table 1: Descriptive Statistics by Treatment

			ABM	SBM	VBM	Overall
TTF		Mean	4.06	3.89	4.01	3.98
		S.D.	0.51	0.29	0.42	0.40
Actual Performance	KNT	Mean	7.00	9.00	8.46	8.24
		S.D.	2.41	1.24	1.39	1.85
	KFT	Mean	8.00	9.14	7.85	8.37
		S.D.	2.00	1.88	1.52	1.85

Table 2: Results for Training Methods

VARIABLE		Hypothesis	Result in Correct Direction	Significant p-value
TTF		ABM>SBM	T	n.s. (p=0.569)
		ABM>VBM	T	n.s. (p=0.940)
		VBM>SBM	T	n.s. (p=0.758)
Actual Performance	KNT	ABM>SBM	F	p=0.006
		ABM>VBM	F	p=0.043
		VBM=SBM	T	n.s. (p=0.417)
	KFT	ABM>SBM	F	n.s. (p=0.124)
		ABM>VBM	T	n.s. (p=0.836)
		VBM>SBM	F	p=0.070

For the hypothesis testing on the actual performance in the far transfer tasks, only Hypothesis H3c is not supported. This indicates that VBM is a more effective approach than SBM to

improve the actual learning performance in the far-transfer tasks. This further affirms the importance of integrating social presence factor into the OAL media, particularly for the purpose of transferring far knowledge. Not as predicted in the hypotheses, the effectiveness of three training approaches for the measure of knowledge far-transfer is in the order of SBM, ABM and VBM. There is no statistical evidence to support the relation between the ABM and VBM, and between the ABM and SBM. This indicates ABM may be equally effective in relation to VBM and SBM. A larger sample size may be needed to capture their difference. Contrary to the predicted direction between VBM and SBM, subjects receiving SBM have a higher performance than subjects receiving VBM in the measure of far-transfer tasks. This indicates that SBM may be an effective alternative to VBM to improve the actual learning performance in the far-transfer tasks.

6. DISCUSSION

Although few of the hypothesized relationships are fully supported, the results obtained can be of interest to educators and training organizations. There is no statistical justified reason for preferring ABM, SBM or VBM for perceived values. In contrast, there is statistical justified reason for preferring SBM to ABM and VBM to ABM for actual performance in the near transfer tasks. The disparate pattern of results indicates that ABM is the least useful approach. Novice subjects in this study may have trouble of self-studying by themselves because of their inexperience. Therefore, ABM's higher control capability, but lower guidance of ABM approach, may result in learning ineffectiveness. Social presence is a factor which may not be able to significantly improve a subject's performance in near-transfer tasks. User control is a more important factor for this type of tasks.

For the far-transfer tasks, social presence may be another inhibitor if it is not well integrated into OAL media. Subjects receiving VBM has a significantly lower performance in far-transfer tasks than subjects receiving SBM. The social presence can be a distraction for users. Instructors may want to adopt SBM to improve a user's performance in far-transfer tasks because subjects can have a better focus. ABM somewhat improves a user's performance in far-transfer tasks, compared to VBM. However, it is hard to say which approach is more effective without enough statistical evidence to support.

7. CONCLUSION

The success of an online training strategy depends on (1) the selection of right media to improve a user's perceived values about the online course, and (2) its effectiveness in improving learning outcomes. This study examines the relative effectiveness of the behavior modeling approach in transcription and video, in relation to animation.

The results from this experiment provide an empirical basis for the development of an online behavior modeling strategy: 1) three multimedia BM approaches are equally suitable for software training tasks, 2) SBM is more effective than ABM for short-transfer tasks, 3) VBM is more effective than ABM for short-transfer tasks, and 3) SBM is more effective than VBM for far-transfer tasks. What is learned from this study can be summarized as follows: When conducting software training, it may be almost as effective to use SBM as it is to use a more costly video-based or animation-based training to improve the perceived values of online learners. To improve a learner's performance in near-transfer tasks, VBM and SBM are more effective than the more costly ABM approach. To improve a learner's performance in far-transfer tasks, an instructor can choose the least costly SBM approach. If the cost is a concern, the instructor may want to first consider adopting the least cost SBM, followed by VBM and ABM. The study has accomplished its major goal - it provides evidence as to the relative effectiveness of the behavior modeling approach delivered in technologies with differential degrees of social presence. This research somewhat improves the generalizability of theories on the behavior modeling approach in different learning environments.

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