HYPER-LINK TEACHING AND INTELLIGENT SLIDES: COMPLEMENTARY STRATEGIES TO FOSTER ACTIVE LEARNING

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Active learning opportunities are an important element of course design. Most current lecture and course formats do not provide any overt means to encourage this activity—active learning. This paper proposes two complementary strategies that directly contribute to this objective. The first, hyper-link teaching, is an alternative mode of in-class lecture delivery. Executing this mode of teaching requires preparing class handouts as anchors for discussions and sharing control over class conduct with the students. The second, intelligent slides, resembles information bases that we enhance with electronic links, to facilitate exploration of concepts by students outside the classroom. Executing this approach requires leveraging existing slides to include electronic hyper-links across related materials and delivering the materials to students over the world-wide-web. This paper outlines the author's progression from early use of hyper-link teaching through its current version, which integrates intelligent slides. Each technique is motivated, demonstrated, and primary indications are provided about its usefulness. Over a period of two years, these techniques have been successfully integrated in undergraduate and graduate IS courses. Lessons learned during this time are shared with the readers. Educators may benefit from initiating either technique, and then integrating the other if and when they need.

INTRODUCTION

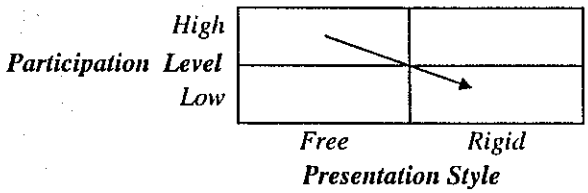
Learning is not a spectator sport. Effective learning requires active student participation (Gamson, 1991). Active learning has been a major theme in course designs over the years (Bennice, 1989; Orzechowski, 1995; Nelson, 1998). Techniques including hands-on assignments, team-projects, class presentations, industry-alliances and research-participation have been implemented for this purpose with considerable success. While such techniques have been proposed and successfully implemented for *application* of concepts learned in class, few techniques have been proposed for active learning of the *concepts* themselves. An exception, perhaps, is the use of CD-ROMs that accompany newer textbooks. These, however, are rarely integrated in class lectures. Learning concepts presented in class, in and of themselves, is also an important element of learning. It is through an active synthesis of concepts that the student arrives at a deeper understanding of materials presented in class. It can lead students to discover concepts on their own, which allows them to remember and integrate concepts more effectively. Synthesis of concepts has been recognized as a key contributor to active learning (Bloom, 1954; Gamson, 1991). The philosophy of requiring an active role from the student in *applying* the concepts has not filtered to the learning and synthesis of *concepts*. Current lecture and course formats provide few overt means to encourage this activity. Occasionally, some industrious students engage in such synthesis, much to our surprise and pleasure. More typically, it is the instructor who implicitly assumes the responsibility for making these connections—often through in-class discussions.

However, with the increasing use of presentation software, in-class practices have evolved (Ross and Fulton, 1994), from early chalkboard style talks to direct-from-the-PC multimedia presentations (or the use of projector slides). With the promise of reuse (and the time it affords for other creative pursuits), many instructors have elected the strategy of investing considerable effort in creating such class presentations.

With easy access to such presentation techniques and the widespread availability of PCs in university classrooms (McCarthy, 1993), the class sessions are slowly but unmistakably beginning to assume a high-tech presentation mode (Anon, 1995; Rupp-Serrano, 1992; Tebbe, 1989). While the multimedia presentation format has captivated the student, it has reduced student participation in class lectures and relegated the student to a more passive role (see Figure 1). As it has forced a rigid mode of lecture delivery on the instructor, perhaps sensing the instructor's reluctance to deviate from the technology-enforced game plan, it has discouraged the student from active participation in class.

FIGURE 1

CHANGING ROLE OF STUDENTS IN THE CLASSROOM



For outside-class activities, techniques that require student involvement through *application* of concepts have been emphasized. However, little has been required of the students to think about and reflect upon the *concepts* themselves. The students have been given no overt means to learn, explore and synthesize concepts on their own outside the classroom. Such a capability is necessary according to Piaget's model, which views learning as the active process of modifying one's mental framework. The cognitive conflict that ensues, when an individual encounters an unfamiliar idea that does not easily fit into her/his mental framework, is resolved by a modification of the mental framework. Providing opportunities to manipulate the material can facilitate this process. No specific techniques are afforded to the student for outside-the-classroom activities under any of the current practices.

We believe that it is necessary to provide overt means (during in-class lectures as well as for outside-class learning) to facilitate such synthesis of concepts. We propose two complementary techniques to address this gap. The first is an alternate mode of lecture delivery—Hyper-Link Teaching—that represents a conscious effort to step back from sophisticated presentation modes to promote active synthesis of concepts on the part of the students. The second—Intelligent Slides—represents a plausible extension of this approach to outside-the-classroom student activities, which provides students a specific resource that may be exploited engage in active synthesis of concepts. The remainder of the paper is organized in four sections. The next section describes and proposes the hyper-link teaching mode. It explains operation of the lecture mode and highlights pedagogical benefits anticipated. Section 3 describes use of the approach in an undergraduate systems analysis class, along with practices used for evaluation of the impact and reports the results. In section 4, we present the complementary technique, intelligent slides, describe its implementation, and report on its use in a graduate database management class. Finally, section 5 presents a discussion of results, caveats for interpretation, shares lessons learned with other educators and indicates future research and improvement directions.

HYPER-LINK TEACHING

In principle, hyper-link teaching involves conducting class lectures as discussions anchored to class handouts and sharing control over the conduct of class sessions with the students (Purao, 1997a). The idea sounds deceptively simple. However, using it effectively requires some planning, and can lead to potent contributions to teaching. Here, we explain fundamental aspects of hyper-link teaching by juxtaposing them against comparable aspects of multimedia presentations and discuss practices required to execute hyper-link teaching.

Generally, the elemental building block of class lectures today is a 'slide,' prepared with a presentation software package. These form the basis of class presentations and are often augmented with multimedia content. Often, the presentation is conducted by directly projecting the slides from a workstation or personal computer (or sometimes, with a simple projector). With this presentation mode, a typical class session proceeds in a predetermined fashion, with each slide building on material presented on earlier slides (see Figure 2(a)). Slides are presented in a logical manner, often with additional information contributed by the instructor. The flow of slides, however, is strictly linear. Few deviations, if any, are encouraged or even permitted by the instructor. Hyper-link teaching, on the other hand, facilitates and encourages a dynamic path through the

FIGURE 2

MULTIMEDIA "PRESENTATIONS" VS. HYPERLINK "TEACHING"

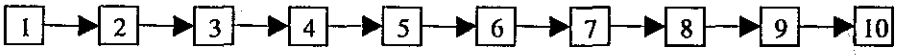


Figure 2 (a) Multimedia Presentation

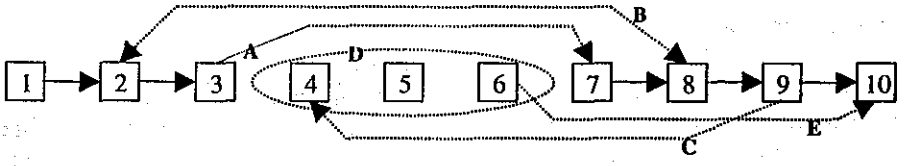


Figure 2 (b) Hyper-Link Teaching

An Example of Hyper-Link Teaching

The class begins with the instructor discussing concepts on slides 1 through 3. At this point, a question comes up regarding possibilities of using a construct introduced on slide 3. The *class* decides to jump (**A**) to slide 7 that shows an example of such use. The discussion is continued with more examples that appear on slides 8 and 9. While discussing slide 8, a reference (**B**) is made to a construct discussed on slide 2. After discussing slides 8 and 9, the *instructor* reverts (**C**) to slide 4 and the discussion proceeds again. The *instructor* now asks (**D**) the students to read together concepts presented on slides 4 through 6 and answers questions. The jump (**E**) to slide 10 wraps up the session.

lecture materials (see Figure 2(b)). The discussion typically flows in a non-linear fashion. Deviations are encouraged and control is shared between the instructor and the students. Figure 2(b) schematically represents the conduct of a typical class session using hyper-link teaching.

Executing Hyper-Link Teaching

Executing hyper-link teaching requires viewing individual slides as *anchors* for class discussions, rather than one in an ordered set for structured presentations. This demands preparation of each slide as a relatively independent unit. Each slide contains important concepts and examples (sometimes with related questions). For IS courses requiring a technical orientation (e.g. database management systems), the slides also contain definitions, problems and specific technical details. Though many of these elements are part of conventional class slides, hyper-link teaching allows formal and comprehensive inclusion of these. The slides are numbered and are delivered to the students in N-up (3-up or 6-up) format prior to the lecture (say, over the world-wide-web). The students are encouraged to (i) go over the slides, and (ii) attempt the questions from the slides—prior to the class session. The questions are placed strategically on the handout to serve as decision points for possible alternate hyper-links.

These handouts form the basis for class discussion. The class session proceeds as a 'discussion of slides' from the handout. No presentation software or overhead projector is used. Since the instructor and the students have the same class handout, with numbered pages and slides, reference to specific parts of the handout is easy. The session is conducted by the instructor and the students in an informal manner. The discussion often

pivots around decision points provided in the slides. In response to concerns raised by students, the instructor sometimes decides to 'jump' to a slide out of sequence, in effect, forming hyper-links through the slides. This also involves choice—among multiple paths pointed to by student concerns—by the instructor. Often, class discussions evolve to integrate concepts, examples and ideas from multiple slides. The format also allows varying the amount of time devoted to one or more slides compared to others. Since the students are aware of the agenda for the class session—discussing the materials available on the handouts—they share responsibility (with the instructor) for managing the time spent on different parts of the handout. The discussion very often involves backtracking to a previously visited slide when students begin to make connections among concepts discussed on different slides. On occasion, the instructor also suggests that students simply read some slides allowing them a few moments of quiet reflection on difficult material. The 'big picture'—the topic for the day—often acts as the guiding principle, in case conflicts arise during the class session.

Pedagogical Benefits

On reflection and after encountering reports from other educators who have grappled with similar issues (Orzechowski, 1995; Rangachari, 1995), hyper-link teaching appears to capture some aspects of Piaget's (Libby, 1995) model of the learning process. Piaget views knowledge as a mental framework that allows an individual to manipulate objects or ideas. Learning is the *active* process of modifying one's mental framework to incorporate a broader range of life experiences. Carried out in small, discrete steps, it is triggered when the individual encounters an unfamiliar idea that does not easily fit into her/his mental framework. The cognitive conflict that ensues is resolved only by a modification of the mental framework. One of the prerequisites to successful resolution is the opportunity provided to the learner to manipulate the material. This involves quantizing the material in small chunks to avoid overload situations. In hyper-link teaching, the slides are designed to be independent units designed to illustrate a single new concept. Presenting multiple chunks simultaneously also suggests a pattern or a framework in the new material that the students *discover* as they proceed through the slides. The ability to view multiple slides simultaneously and backtrack as required also provides the students opportunities to synthesize (Bloom et al., 1954; Gamson, 1991) the concepts across slides in a framework that is uniquely their own. The instructor becomes more conscious of the students' need to create their own frameworks and responds, as needed, to help the students in the learning process. Specific pedagogical benefits from hyper-link teaching, then, can be summarized as shown in Table 1.

TABLE 1

PEDAGOGICAL BENEFITS OF HYPER-LINK TEACHING

Promotes Active Student Participation	By handing over to the student partial control of and responsibility for conduct of class discussions, the proposed approach requires and elicits active participation from students.
Provides Opportunities for Synthesis	By allowing the students to direct the flow of discussion, the proposed approach provides the students opportunities to form links among concepts from various slides.
Augments Instructor Responsiveness	By releasing the instructor from the burden of a rigid plan, the proposed approach provides flexibility to the instructor to quickly respond to students' questions and concerns.

USE AND EVALUATION

The hyper-link teaching approach was first used for an undergraduate course in systems analysis in Fall 1995. The changes mostly involved (i) incorporating additional materials in existing slides with a view to making each slide stand on its own, and (ii) integrating decision points on some slides to promote student interaction and serve as possible jump-off points to other slides.

Use

The handouts were made available to the students, ahead of class, via the world-wide web. Typically, the students were required to obtain slide handouts 1-2 weeks ahead (instead of at the beginning of the term) to maintain a sense of continual, active interaction. During the first few weeks, students were repeatedly encouraged to (a) read the handouts, and (b) answer questions on the slides—before the class meeting. As the term progressed, the students appeared comfortable with this routine. Many 'planned' to spend time on the handouts before class and some requested class handouts early to fit their schedules.

Early in the term, class sessions proceeded in a relatively linear fashion with the students content to follow the sequence of slides on the handouts. Fearing an impression of unplanned class discussions, neither did the instructor initiate any hyper-links through the slides. As students became aware of the freedom afforded to them and overcame some of the inhibitions, the class sessions turned more lively and required tracing nonlinear paths through the class handouts, coupled with extensive use of the whiteboard to further illustrate or explain points raised by students. Though in-class time management was an issue, and posed a problem in a few sessions; students often compensated for the time over multiple sessions. Other than a few sessions that involved software demonstrations and hands-on use of the software, this pattern continued through the rest of the term. The implementation was an apparent success and students openly complimented the instructor for adopting this lecture format.

Evaluation

Evaluating the success of hyper-link teaching was a difficult task. As the term progressed, it was abundantly clear that success with this format was the product of a complex interaction among three sets of variables: characteristics of the instructor, those of the students, and the nature of the course material itself. Exact measurement was almost impossible considering the non-controlled environment. To provide an indication of success of hyper-link teaching, it was decided to employ two forms of measurement (similar to those followed in Beranek (1995)).

The first was an in-class survey (see Appendix A) conducted at the end of the term. It was designed to gather students' impressions about hyper-link teaching. The questions (on a five-point Likert scale) were designed to reflect different aspects of the three pedagogical objectives (see Table 1) as well as general impressions about the format. The second was a comparison of grades across two sections of the same class taught by the same instructor in two different terms—one incorporating hyper-link teaching and the other without. These would, of course, be subject to the caveats mentioned in Beranek (1995), such as the learning effect.

Of the 25 students enrolled for the class, 20 were present on the day the survey was administered, which was not an anomaly considering the attendance patterns of the class in other terms. No surveys needed discarding in spite of some apparent but minor inconsistencies in responses. Twenty usable surveys were available for analysis. Results from the survey are summarized in Tables 2 and 3 .

TABLE 2
STUDENT CHARACTERISTICS

Demographics	
Average Age	23.89
Gender	
Male	50%
Female	50%
Year in School	
Junior	6
Senior	11
Graduate	1
Unknown	2
Exposure to Different Lecture Modes	
Online slides on world-wide-web	65%
Multimedia Presentations	70%
Overhead Projector Presentation	100%
Chalkboard or other Write-On	100%
Open Class Discussion	100%
Number of Students Enrolled	25
Number of Survey Respondents	20

TABLE 3

SURVEY RESULTS

Scale: Best | 1 | 2 | 3 | 4 | 5 | Worst

Objective 1: Promote Active Participation		Mean	StdDev
5.	Provided chances to contribute to discussion.	1.95	0.62
9.	Felt I could ask questions easily.	2.05	1.03
13.	Allowed backtracking when required.	1.90	1.02
Objective 2: Provide Opportunities for Synthesis		**Mean**	**StdDev**
3.	Was easier to see where we were and where headed.	1.65	0.67
6.	Gave opportunities to digest material at different speeds.	1.55	0.60
8.	Provided opportunities to see the big picture.	2.00	0.97
10.	Created links across material from different slides.	1.95	0.71
Objective 3: Augment Instructor Responsiveness		**Mean**	**StdDev**
4.	Lead to interesting and lively discussions.	2.15	0.88
12.	Allowed flexibility in time spent on each slide.	2.25	1.12
14.	Allowed instructor opportunity to respond to questions.	2.00	1.03
General Impressions		**Mean**	**StdDev**
1.	Gave an impression of unplanned discussion of ideas*.	1.33	1.41
2.	Difficult to coordinate slides with the instructor*.	1.70	0.66
7.	Was boring since it did not involve PC presentations*.	1.79	0.85
11.	Did not give picture of the overall topic*.	1.65	0.67
15.	I liked this format.	1.90	1.02

* adjusted for reverse scored questions.

Numbers refer to question numbers on the survey (see Appendix A).

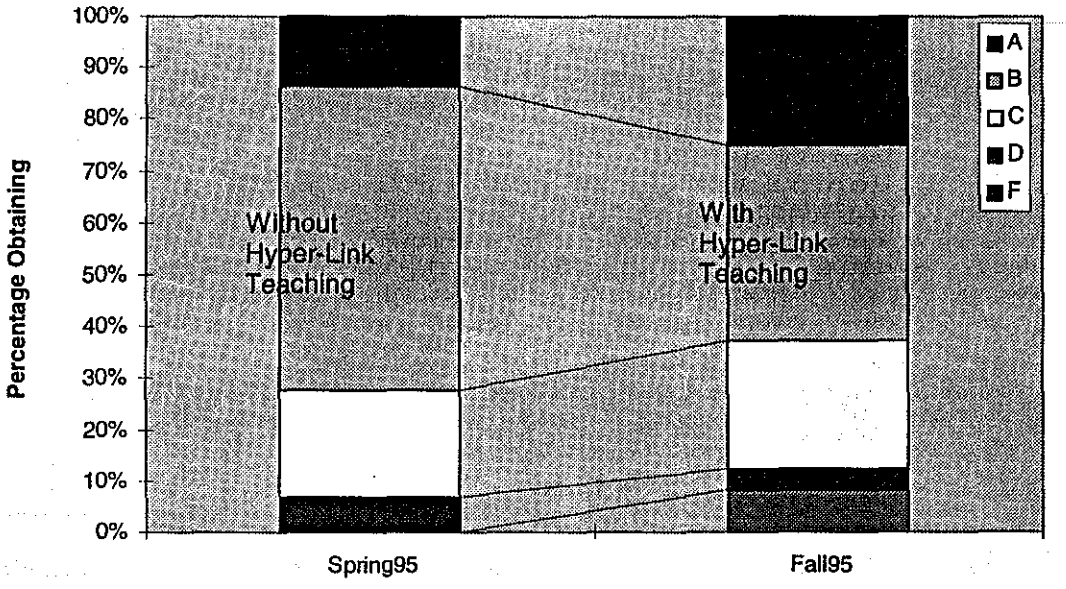
Clearly the student group represented was diverse and had been widely exposed to many other forms of lecture delivery. Also, since all the students were reasonably advanced in their education (Junior year or above), they presumably had the maturity to accept and exploit a given mode of lecture delivery. In view of this, the following survey results are particularly encouraging.

The results clearly indicate that hyper-link teaching found favor with the students. The approach was liked in general, and apparently contributed well to the three pedagogical benefits outlined earlier. It was particularly satisfying to see that some of the impressions that the instructor formed during the term were validated by student responses. Questions measuring different aspects of the first objective averaged 2.05 or less (on a scale of 1-5, where 1 indicated the best score). The comparable averages for objectives 2 and 3 were 2.00 and 2.25 respectively.

Grade distributions for Spring and Fall 1995 are plotted in Figure 3 . The change in grade distribution (from Spring 95 to Fall 95) indicates migration of students away from the large B-grade to either the higher A-grade or to a lower C-D-F-grade. The movement suggests that this mode of teaching may serve to differentiate students more clearly. It is more difficult to speculate about the higher number D's and F's. It is possible that the class sessions were sufficiently interesting and entertaining that this

FIGURE 3

COMPARATIVE GRADES



outweighed the risk of getting a lower grade—prompting students to continue instead of dropping the class. These interpretations are, of course, subject to many caveats (Beranek, 1995). Such caveats and further comments are offered in the Discussion section at the end of the paper.

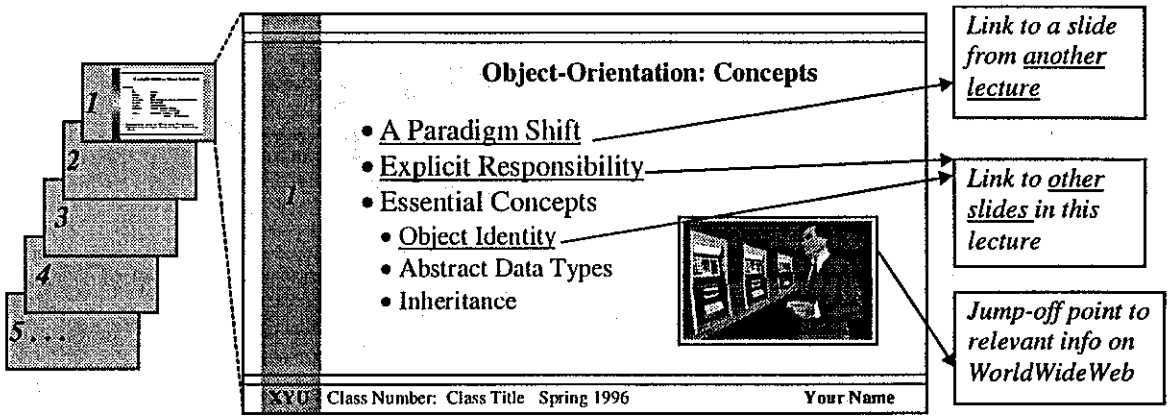
INTELLIGENT SLIDES—A COMPLEMENTARY TECHNIQUE

The complementary technique, intelligent slides, represents an extension of the hyper-link teaching approach to outside-the-classroom activities of students (Purao, 1997). It provides a capability that provides students ample and explicit opportunities to explore and synthesize concepts, within and across lectures as well as across related external materials. This description of intelligent slides immediately brings to mind the world wide web and recent (now widespread) practice of using the Web for delivery of course materials such as lecture slides. As currently practiced, this mode of delivery facilitates physical links, say, between the course schedule and lecture slides. However, these links remain at a coarse level of granularity, say, between files. Semantic links across specific topics are not formed. Our conception of intelligent slides calls for an approach similar to the 'Help' facility found in many of today's software packages, that is, a hypertext approach that provides jump-off points across different concepts presented on individual slides. This allows links, at the appropriate level of granularity, across different but related topics. Ideally, intelligent slides that can be used by the instructor (in the classroom) as a basis for class discussions or presentations, as well as by students (outside the classroom) to explore the subject matter (see Figure 4).

The analogy to hypertext-based solutions is clear in Figure 4. At first glance, two existing hypertext technologies appear as plausible implementation candidates for this problem. One involves constructing the information-base as a 'Help' feature. The other

FIGURE 4

INTELLIGENT SLIDES



Slides used in class for Lectures by the instructor, and out of class for exploration by the students.

involves development using the increasingly popular *world-wide-web*. Though they satisfy some requirements (see Table 4), neither allows easy integration with lectures—which is critical for adoption by students and instructors.

TABLE 4

IMPLEMENTATION OF CANDIDATES

Requirements	**Help**	***Web***
Internal Links	Yes	Yes
External Jump-off Points	No	Yes
Implementation Effort	High	Low
Integration with Lectures	No	No

The other problems with implementing a full-scale hypertext solution are also important. First of course, is the effort required to implement the solution, which is magnified in a fast-changing field such as Computer Information Systems. Second, and perhaps more important is the (in)ability to use such a solution directly for class lectures—which remain a critical component of course delivery today. Since educators rightfully expend a considerable amount of time and efforts on developing lecture presentations, a hypertext solution that is independent of lecture preparations cannot be justified. Additionally, it would be beneficial if the jump-off points could connect not only different topics with one another, but also with externally available resources such as those on the world-wide-web. Further, some ancillary, yet important requirements can be identified for a workable solution. These are: (a) the lecture materials should be viewable/printable, but should not be manipulatable, safeguarding intellectual property, (b) the solution should preserve current investments in course preparation by allowing leveraging of existing slides, (c) the solution should not force use of a specific presentation software package (such as PowerPoint™), and (d) the lecture materials should also be uniformly accessible across platforms (such as PCs or Macs) to different students.

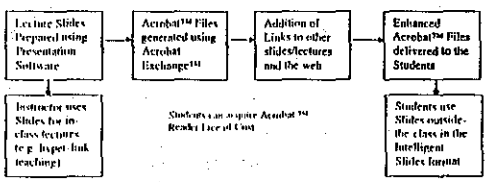
Implementation

It was realized that implementing Intelligent Slides would require imaginative use of existing capabilities of software tools. Tools such as PowerPoint™, Visual Basic™, and ToolBook™ were explored before settling upon the eventual choice, Adobe Acrobat Exchange™, which provides, admirably, all the requirements outlined above. Figure 5 outlines the process of creation, delivery and use of these slides, where the

shaded boxes indicate additional work relative to traditional lecture preparation.

FIGURE 5

CREATION AND USE OF INTELLIGENT SLIDES



It maintains use of lecture slides in the classroom, and enhances and organizes them in an information-base—with hypertext links to related concepts and jump-off points to external information sources. The information-base can be browsed by students outside the classroom for exploration and synthesis of concepts. The feasibility of this approach was first tested for a graduate Database class at the author's home institution. The implementation required use of the software Adobe Acrobat Exchange™, which was available at the university. With this software, existing lecture slides can be 'printed' to an electronic format - called portable document format (PDF)™. The software then allows enhancement of these with links across slides/across lectures or to specific locations on the web. The enhanced course materials were delivered to students over the world-wide-web. Use of the slides by students required an Adobe Acrobat™ Reader, which could be obtained free-of-cost (Adobe, 1998). Figure 6 shows a sample snapshot of the implementation. Additional snapshots are shown in Appendix B.

The approach was successful in seamlessly integrating out-of-class student explorations with in-class lectures. Student response was positive. Use of links was reported on various occasions: preparing for class, refreshers on earlier concepts, and seeking further information. The students easily took to using the information-base. Based on the quality and nature of class discussions, it appeared that the students did use the information-base to explore and synthesize concepts from lectures. Making the slides available to the students did not affect class attendance, which remained similar to patterns observed in other terms. Table 5 summarizes the benefits. Currently, this technique is also an integral part of lecture design by the author in multiple courses.

FIGURE 6

A SNAPSHOT FROM THE IMPLEMENTATION

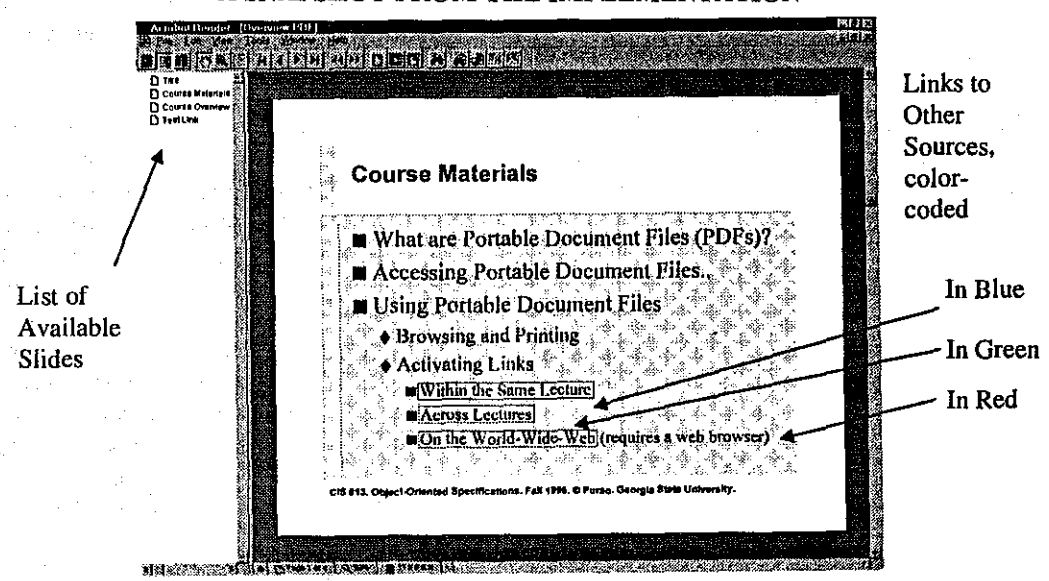


TABLE 5

BENEFITS OF INTELLIGENT SLIDES

Benefits	
Internal Links	Yes
External Jump-off Points	Yes
Implementation Effort	Low
Integration with Lectures	Yes
Leveraging existing Slides	Yes
Safeguarding Intellectual Property	Yes

DISCUSSION

The hyper-link teaching technique has clearly found favor with the students. The survey results confirm this impression. Student responses about the teaching format were surprisingly uniform. The format facilitated active participation (pedagogical objective 1) by sharing control over the conduct of class sessions with the student. It provided students ample opportunities for synthesis (pedagogical objective 2) by allowing non-linear and dynamic paths to evolve during class sessions. Finally, it augmented instructor responsiveness to student concerns (pedagogical objective 3) by permitting backtracking, skipping and bundling of slides. The *statistics* must be interpreted with caution since they are (i) based on a small sample (20 students), and (ii) do not span multiple instructors or courses.

Some speculations can, however, be made from the statistics and anecdotal evidence observed over the last two years. First, it appears that technology-enforced, structured classroom presentations may actually be harmful to the learning process. The rigidity introduced by presentation software packages may inhibit student participation. Hyper-link teaching allows a mode of instructor-student communication that naturally evolves to informal interactions, which leads to surfacing of student concerns. Second, the format also results in a more 'personal' approach to teaching that students appear to like. Student evaluations also indicate this fact. For instance, the statements 'Cares about the quality of his/her teaching' and 'Has a genuine interest in students' resulted in a rating of 5.0 (on a 5 point scale). Placed against an average of 4.0, this appears to indicate the success of hyper-link teaching in *reaching* the students at a personal level. Finally, one entirely unexpected benefit of the approach that is being realized by the author is the ability to reuse individual slides from presentations in new contexts. Since the slides are designed to be independent units (instead of part of an ordered presentation) it is relatively easier to create new class presentations for different target audiences - by assembling slides from multiple presentations.

The intelligent slides technique has complemented hyper-link teaching well. The implementation effort required for enhancing the slides with electronic links has been low. After the initial tendency to add a multitude of links, the author has settled on adding no more than one link for every two slides, on average. The scaling back in terms of number of links has been prompted by maintenance and update issues. As more links are added, the chances of finding 'dangling' links increase as slides are deleted. In addition to reducing the number of links, we have also adopted the practice of adding bi-directional links, to warn ourselves of the possibility of 'dangling' links. Other than this concern, update and maintenance has not been a major issue. The software allows easy 'extraction' and 'insertion' of slides, making maintenance fairly routine. However, making major changes can be quite cumbersome. Another concern was the issue of copyrighted materials that the slides pointed to. However, since the material was not 'included,' this was not considered a problem. Printing concerns were sometimes voiced by lab administrators, who indicated that students extensively used the printer consumables. A corresponding decrease in departmental photocopying costs was also observed.

Another benefit discovered is the ability of the software to do full-text searches. Thus, a search on the term "referential integrity" could lead to the relevant slides in a database management course. We also found that intelligent slides could serve as an information-base that contains many more slides that are not discussed in class, but were 'pointed to' by slides discussed in-class. Also, links to specific locations on the world-wide-web could also be integrated into the slides. These last two capabilities allow the instructor to guide the students to additional relevant materials. For example, while discussing the advances in database systems, a link to MapQuest (a geographic database on the world-wide-web at www.mapquest.com) could make the point much more strongly than a class discussion. Over the last

year, with new versions of software such as Powerpoint™, the ability to embed hyperlinks is now available. However, these are cumbersome (e.g. they require 'naming' different 'locations' in destination files), unlike the implementation we suggest. In spite of this, it is possible that a presentation software, such as Powerpoint™ be used for implementing intelligent slides, with consequent loss of some of the functionality mentioned above.

Both approaches—hyper-link teaching as well as intelligent slides—are now an integral part of the author's teaching portfolio. Both have been tested in multiple terms, for different IS courses, both graduate and undergraduate, over the last two years. The results have been extremely encouraging, as evidenced by a jump in the instructor effectiveness rating from 3.3 to 4.8 (on a 5 point scale) for one of the classes, over a span of two terms. Other instructors at the author's home institution have also adopted one/both techniques. Educators at other schools can easily adopt the techniques. Adopting hyper-link teaching requires a change in 'orientation' more than anything else. To adopt intelligent slides, the adopters are not required to start anew; existing lecture slides can be easily enhanced to take advantage of the technique. It is our hope that the description and lessons we have shared with the readers will help in this process.

The intent of this paper has been to describe and illustrate the techniques and to provide anecdotal evidence of their effectiveness. Due to the limited nature of the evidence, the data presented should not be viewed as conclusive proof of the superiority of the techniques. Alternative explanations for the positive outcomes are certainly possible. For example, the instructor may have been more prepared, enthusiastic or energetic as a result of preparing new techniques; the students may have been eager to please the instructor for trying a new technique or using a new technology. The difficulties in arranging a suitable controlled study, and the ethical dilemmas associated with it, also contribute to the paucity of the data. To ensure that the techniques are working well, we plan to (and encourage potential adapters to) have the students produce reviews or summaries that demonstrate synthesis of concepts. With suitable warnings, it may also be possible to allow students to create additional links.

At a more general level, the approaches we have suggested can instill active learning habits and prepare students for life-long learning. The rapid rate of change in the IS and business environment suggests that individuals will need skills applicable to researching and learning new technologies for the foreseeable future. Our suggestions are relevant for all IS courses, technology-focused as well as managerial, and integrates the techniques for in-class learning as well as outside-class activities. Another approach, more relevant for courses with a higher managerial content, is the Mondex global case study organized by Ives (1997), which used the internet as a medium that allowed interactions among faculty, students and executives who could also explore a rich, hyper-linked set of materials on the net.

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APPENDIX A

QUESTIONNAIRE USED TO GAUGE REACTIONS TO HYPER-LINK TEACHING

This questionnaire solicits your feedback regarding the Teaching Format used in class.

Please Tell me about Yourself (anonymous)

Age: _____ Year in School: Freshman / Sophomore / Junior / Senior / Graduate

Gender: F / M Work Status: FullTimeStudent / WorkingPartTime / WorkingFullTime

Please Tell me about Presentation Formats in other Courses You have Taken

How many courses have you taken so far at GSU (or other universities)? _____

Which of the following Presentation Modes have you experienced?

- Viewing OnLine Slides on the WorldWideWeb Y | N
- MultiMedia (Audio and Video) Presentations Y | N
- PowerPoint Slides or other (direct from the PC) Presentations Y | N
- Trasparencies on Overhead Projectors Y | N
- ChalkBoard or other Write-On Presentation Y | N
- Open Class Discussion Y | N
- Other. Please Specify: _____

Please tell me your impressions about the Teaching Format.

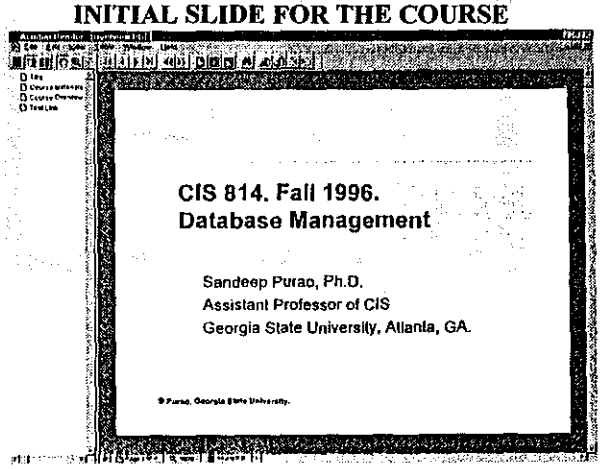
		Agree			Disagree		No Opinion
1	It gave me an impression of unplanned and random discussion of ideas.	1	2	3	4	5	0
2	It was difficult to coordinate the specific slide I was looking at with the material the instructor was discussing.	1	2	3	4	5	0
3	It was easier to see where we were and where we were headed.	1	2	3	4	5	0
4	It was interesting because it was always a lively discussion.	1	2	3	4	5	0
5	It provided me with multiple chances to contribute to the class discussion.	1	2	3	4	5	0
6	It gave me the opportunity to digest material from different slides at different speeds.	1	2	3	4	5	0
7	It was boring since it did not involve any PC-based presentation.	1	2	3	4	5	0
8	It provided me opportunities to see the big picture.	1	2	3	4	5	0
9	I felt that I could ask questions more easily to clarify some points.	1	2	3	4	5	0
10	It helped me in creating links in my mind across material on different slides.	1	2	3	4	5	0
11	It did not give a clear picture of the overall topic being covered on that day.	1	2	3	4	5	0
12	It allowed flexibility in time spent on each slide before moving on.	1	2	3	4	5	0
13	It allowed me to clear up some questions by backtracking, if required.	1	2	3	4	5	0
14	It appeared to allow the instructor time and opportunity to respond to my questions.	1	2	3	4	5	0
15	I liked this teaching format.	1	2	3	4	5	0

APPENDIX B

SNAPSHOTS FROM IMPLEMENTATION OF INTELLIGENT SLIDES

Figure B.1 shows the list of slides on the left, and the first slide in the lecture. Any slide in the list may be clicked to view that slide. The Course Overview slide shows the topics covered in different lectures.

FIGURE B.1
INITIAL SLIDE FOR THE COURSE



Each topic is a hyperlink (shown in Green on the screen) that could be clicked to access the relevant lecture.

FIGURE B.2
COURSE OVERVIEW

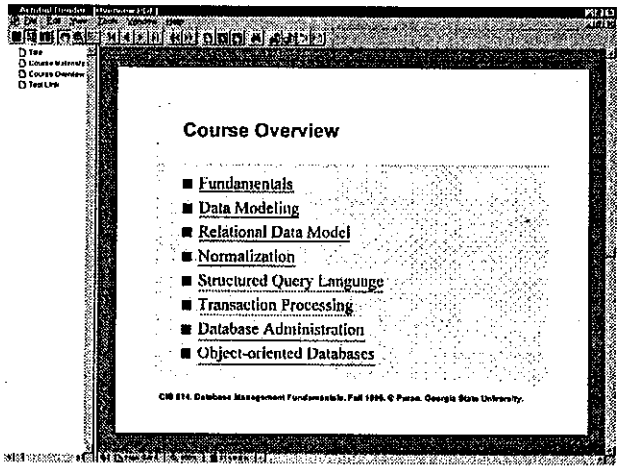
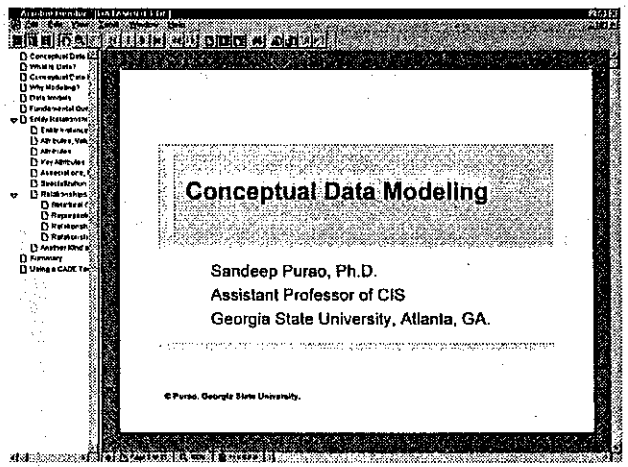


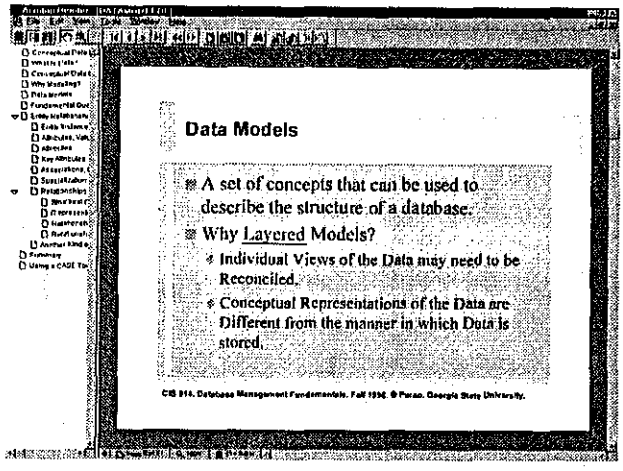
Figure B.3 shows the first lecture, which is accessed by clicking on the appropriate topic in the previous slide. On the left is the list of slides in this lecture, which is logically grouped, and may be collapsed (or opened) at different levels.

FIGURE B.3
LECTURE ON CONCEPTUAL DATA MODELING



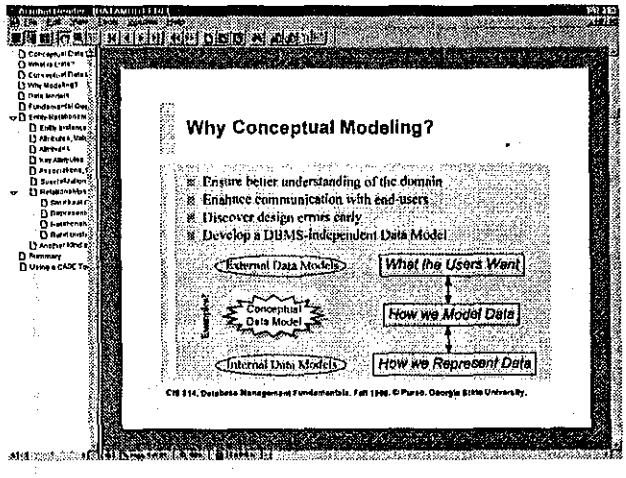
Another slide from this lecture is shown in Figure B.4. This slide shows another hyperlink - the word, Layered - which is underlined in blue to indicate that this is a link to another slide within the same lecture.

FIGURE B.4
A SLIDE IN THE LECTURE ON CONCEPTUAL DATA MODELING



The slide shown in Figure B.5 is accessed by clicking on the hyperlink indicated in the previous figure. It represents slide 3 in the lecture, as seen from the list of slides on the left.

FIGURE B.5
ANOTHER SLIDE IN THE SAME LECTURE



At the bottom of the slide in Figure B.6 is a question (underlined), which provides another hyperlink. Clicking on that line will access a slide that provides an answer to this question.

FIGURE B.6
A SLIDE, FULL VIEW, IN THE LECTURE RELATIONAL MODEL

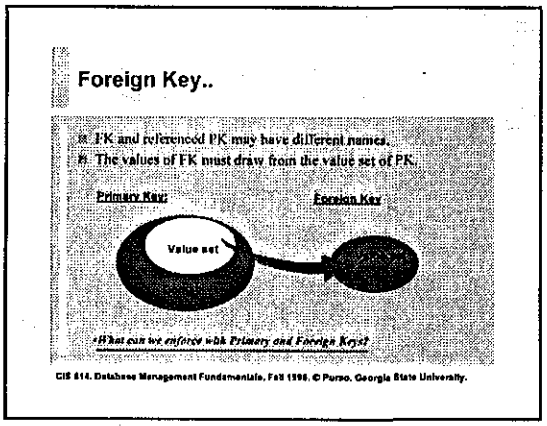


Figure B.7 shows the slide accessed by clicking on the hyperlink indicated in the previous figure. In this slide, there is an additional hyperlink, indicated by the boxed questions that appear at the bottom. Clicking on this hyperlink will access another slide (not shown here) that may provide answers to these questions.

FIGURE B.7
ANOTHER SLIDE, FULL, VIEW, IN THE LECTURE RELATIONAL MODEL