Communications of the IIMA

Volume 7 | Issue 2 Article 9

2007

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ABSTRACT

University-level instructors work in an environment where new technology-based teaching tools are created daily. Most instructors are not formally trained in these technologies, so they must determine by trial-and-error which tools are effective. This paper describes a research project that develops a new blended course architecture that combines the best traditional and online tools. The architecture was implemented into two classes and students were surveyed. The results of the survey show that 87.7% of the students perceive the new architecture to be effective. Further, key components in the design are shown to be very useful individually and in combination.

A NEW BLENDED COURSE ARCHITECTURE FOR THE MODERN UNIVERSITY

Teaching at the university-level has become a much more complex endeavor in the last decade. Prior to that time, courses were designed around the classic time-tested components of live lecture, handouts, homework, and periodic tests. While computer technology was available, it rarely was utilized in the classroom as a teaching tool and was never utilized as a common classroom learning implement by students. Instead, technology was relegated to the computer lab for projects or to special demonstrations that required extensive setup and planning on the part of the instructor. Some cutting-edge instructors may have used PowerPoint™ instead of overhead slides in the classroom, but for the most part, teaching was the same as it had been for decades.

Then the revolution occurred. The combination of inexpensive hardware, vastly improved infrastructure, creative software, and the Internet laid the foundation for a new era in education. Learning was no longer limited to the physical confines of the classroom and the content limitations of the textbook (and instructor). World-class external resources were freely available and only a mouse click away. All courses and textbooks were expected to support dedicated web-sites. Entire college campuses were outfitted with wireless Internet hardware so that teachers and students could access these resources easily at any time. Lectures could be streamed, handouts downloaded, homework machine-graded, and tests given 24x7 anywhere the Internet was available. University-level education was thrust into the 21st century.

In the middle of this whirlwind of change was the classroom instructor. Trained and experienced in the classic teaching methods, many found themselves struggling to function in the new technological environment. Others, who were more amenable to the change, were forced to learn by trial-and-error which new technologies are best suited for actual students in a real classroom (Nichols, 2003). The temptation for many in the latter group was to say that all technology is good and should replace traditional teaching methods; however, research has shown that the classic methods are very effective for many students (Ury, 2005). Because of this situation, a dilemma currently exists for the university-level instructor. Which new technologies should be adopted and which should be avoided? How best can the traditional teaching methods be merged and augmented with new technological tools? Of the technologies that are available, which do students prefer and which are most effective?

These questions demonstrate the need for research into innovative course design architectures at the university-level. Teaching professionals work in a rapidly evolving environment where new technologies that impact their job are created daily. Most instructors are not formally trained in the disciplines that create these technologies, so they have difficulty predicting which will be effective and which will not. Without some guidance or overriding architecture it is very difficult for instructors to determine how best to design their courses to take advantage of the available tools.

The project described by this paper developed such architecture. This new framework was used to create two undergraduate business courses which were implemented and taught to students. A survey was given to all students who took the courses to determine the preferences and perceived effectiveness of the technologies embedded in the new structure. The end result of this research is a new blended course architecture that helps instructors takes full advantage of the new technology in a way that is both effective and practical.

THE CASE FOR BLENDED LEARNING

In approaching this research project, the natural first question to ask was, "is there really a problem?" Stated another way, "is there any reason to selectively pick and choose the technologies to include in the course design?" If it is true, as is believed by some, that adding technology to the curriculum improves the course, why not add as much technology as possible everywhere it is possible? That would avoid the dilemma described above and would create the ideal course immediately. On the other hand, what if the traditionalists are correct and technology-enhanced courses are just the latest "bandwagon" in a long line of educational fads (Turner, 1997; Hirschheim, 2005)? From this perspective, adding additional technology elements is unnecessary and counterproductive. To help resolve this question, a careful examination of the educational literature was undertaken. The outcome of this investigation was that a blended approach to instructional design has more positive benefits and potential than either the traditional or online approaches. Further, the literature supports the use of a research methodology called the developmental research model to create this blended course architecture. The following sections provide the detail needed to support these conclusions.

Theories of Knowledge and Learning

Two major theories of knowledge have been adopted into the education literature from philosophy. These are *objectivism* and *constructivism*. The objectivist epistemology, as developed by Rand (1979), assumes that knowledge and truth are objective realities that reside outside of the mind. When applied to the educational environment, it is the job of the instructor to transfer this knowledge from themselves to the mind of the student. Conversely, it is the task of the student to replicate as closely as possible the knowledge that has been made available to them (Tam, 2000). At some point, the student amasses sufficient knowledge so that they can assume the role of instructor and perpetuate the cycle. Because of the nature of the student to teacher relationship, this type of learning is often called "passive learning."

The constructivist epistemology makes the radically different assumption that knowledge does not have external existence (Flavell & Piaget, 1963). Rather, it is thought to be built, or constructed, within the mind of the learner through a complex interplay of the social context, the problem to be solved, and existing knowledge within the learner (Tam, 2000). Because no two learners have exactly the same initial knowledge and experiences, each may construct a unique representation for the same perceived reality. When applied to the educational arena, this theory creates a learning environment where students and teachers work together to discover knowledge through various activities and exercises. The instructor's primary role is to act as guide and facilitator to the student. Due to the nature of this interaction, this type of learning is often called "active learning."

It is important to realize that the objectivist and constructivist learning theories are not tied to any specific instruction delivery method. Thus, the traditional approach to teaching can apply both constructivist and objectivist techniques. Likewise, technology-laden online courses can easily accommodate the didactic components normally associated with objectivist design. Despite this, it is also true that teaching techniques that work well in a traditional class will not necessarily be as effective online (Hirschheim, 2005).

The Traditional Approach

The traditional approach to education is literally ancient. It involves the physical meeting of a teacher who knows the material with a group of students who wish to learn. Over the centuries, various pedagogic tools have been employed to transfer the knowledge from the teacher to the students. The most common are face-to-face lecture, external reading, class discussion, problem sets to solve, homework, and tests. These components can be combined and presented in different ways depending upon the instructor's underlying assumptions about the nature of knowledge and learning.

Until the mid-1990's, the traditional approach to instruction delivery was almost exclusively associated with the objectivist theory of passive learning. The hallmark of this mode of delivery is the lecture. Face-to-face lecture is still considered to be the most efficient means to introduce students to a topic and focus their attention on the most important points (Pullen, 2000). Face-to-face lecture also has the advantage of immediate feedback to student questions with the maximum possible "social presence" as described by Short, Williams, & Christie (1976). Research has shown that student performance, as measured by final course grade, is significantly lower for those taking the online version of a course as compared to the traditional lecture-based version of the same course (Ury, 2004). Another major component to the traditional approach is classroom discussion. This generally falls under the heading of a constructivist technique because it allows students to share and shape their understandings in a social context. When used in combination with group projects and class presentations, the class discussion can be an extremely effective learning technique (Weller, 2002).

The key disadvantage of the traditional approach is its "same time, same place" restriction. In order for a class session to take place, all students and the instructor must simultaneously meet in the same place. This means that geographically remote students and ones with erratic schedules cannot participate in the class. It also means that class sessions are similar to live performances which, once missed, cannot be reproduced. Another problem with the traditional approach is its continued reliance on passive learning techniques. Despite the recent progress to integrate active learning into the curriculum, many courses cannot easily be taught using active methods while others that could use the techniques, do not (Finkelstein, Seal, & Schuster, 1998; Weller, 2002).

The Online Approach

Online learning implies that education occurs only through the Internet without any physical learning materials distributed or face-to-face contact between students and the instructor (Nichols, 2003). The key advantages of online learning are convenience and flexibility (Hirschheim, 2005). These occur because the "same time, same place" requirement of the traditional approach is removed. Class is no longer tied to a physical location or to specific time, so remote students can "attend" class any time they want anywhere they happen to be. Class materials, likewise, are distributed virtually so there is no need to physically shuffle papers. The virtual nature of these class materials also means that new forms of content that could not easily be delivered in a classroom environment can be made available to students. Online threaded discussion and group projects are possible through specially designed communication software as are virtual office hours and real-time chat sessions. Because the online environment is not limited to the material generated by the instructor, these classes literally have access to the full content and resources of the Internet. This creates an ideal environment to implement resource based learning; a form of constructivism that encourages students to develop their understanding by utilizing a wide variety of external views and resources (Weller, 2002). Finally, online class resources can be much more focused and directed to the students' individual needs because they can provide one-on-one instruction on topics that may not be needed by the rest of the class.

From the students' perspective, the primary problem with online learning is that it is missing most of the social context found in traditional classes. Consequently, online students miss the social presence of live lecture and class discussion along with immediate feedback and face-to-face interaction with the instructor. A recent survey found that 74% of students in an online class felt that they received a lower level of education and "missed out" because they took the online version of a class (Hirschheim, 2005). Given that overall performance of online students based on final grades has been shown to be significantly lower than their traditional class counterparts, it is evident that online students are missing out on something that their traditional peers are not (Ury, 2004).

Online courses also have problems from the teachers' point of view. They require more time to prepare and deliver than traditional classes (Boser, 2003; Hirschheim, 2005). Unfortunately, the compensation structure of most universities does not recognize this, so the extra work is not rewarded (Turner, 1997; Gill, 2006). E-mail and other forms of online access create a situation where the instructor is expected to be available 24 hours a day to answer questions (Hirschheim, 2005). In many cases this is not an efficient use of the instructor's time because the same questions must be answered over and over. Another problem concerns the rigor of online courses. According to Hirschheim (2005), many students seek out online courses not only because of the convenience, but also because they believe they will be able to get higher grades with less effort. In part, this explains the common belief that online courses are inferior and should receive greater scrutiny than an equivalent traditional course (Sener, 2004).

The Blended Learning Approach

A blended approach to learning is one where face-to-face lecture and other elements of the traditional classroom are combined with online components to create a learning environment that exhibits the best of both approaches. A major strength of the blended approach is that it presents the course material in multiple ways; thereby allowing individual students to select the method of instruction that works best for them. This is important because individual learners have different educational needs, and a single mode of instructional delivery may not provide the context, engagement, relevance, or choices needed to learn the material. When applied correctly, blended learning is better than either online or traditional methods used alone (Singh, 2003). Research has demonstrated that a blended course can be completed quicker, at a lower cost to the university, and with better overall student learning than a course using traditional delivery methods (Dean, Stahl, Sylwester, & Peat, 2001). Other research has shown that students who are taught in a blended environment perform better academically and were more satisfied than students who were in either traditional or online courses (Goldberg, 1997).

The primary challenge to implementing an effective blended learning environment stems from the selection of technology components to include and the decision of how to apply them. There are a tremendous number and variety of technologies that could be used to teach students. However, one should remember that technology is not pedagogy; rather, technology is pedagogically neutral (Nichols, 2003). Depending upon how it is applied, the same technology can be used to support any pedagogy. Because of this, the selection process must be very closely tied to actual practice and experimentation to determine what works in a real classroom environment. If it turns out that a traditional mode of delivery works better than a technology enhanced one, the traditional mode should be employed. Said another way, "we must take great care that our enthusiasm for novel approaches not lead us to omit something vital" (Kay, 1996, p. 56).

This mode of research is called the *developmental research model* and it is appropriate for the project described by this paper because it does not follow the standard empirical method by attempting to test whether a theory that is applied to practice accurately predicts events. Rather, it attempts to solve real problems and shape the development of theory through an iterative collaboration of researchers and practitioners (Reeves, 2002). It tends to work best in complex situations involving the social sciences and education. Reeves (2002) suggests that this methodology should be used for research that involves using digital content in education because traditional empirical research models are not effective. This lack of effectiveness is demonstrated by the fact that currently there is no unifying theory for electronic learning (Nichols, 2003). Thus, with the developmental research model as the research methodology, the following section describes the architecture that was developed for this project.

THE BLENDED ARCHITECTURE DESIGN

The initial step taken to create the new blended course architecture was to investigate the literature to determine what technology-enhanced components previously had been incorporated into actual classrooms. Special attention was given to research that reported the effectiveness of the final implementation. This search found that a wide variety of technology components had been applied to an even wider variety of learning implementations. From this information, the general categories where technology had been incorporated successfully into educational environments were identified. These categories of components are described below.

- **Class administration** – components to automate (or make Internet available) those tasks that traditionally require instructor intervention or availability.
- **Content capture** – components to aid the instructor in digitally capturing class related content.
- **Content delivery** – components to deliver traditional and uniquely online education content to the student.
- **Content navigation** – components to aid students in linear and non-linear access and search of available educational content.
- **Knowledge-building activities** – components to allow students to pursue resource based learning and active learning endeavors.
- **Assessment** – components to provide formative and summative assessment via the Internet.

The next step was to identify technology components that realistically could be used to implement these general categories in an actual classroom setting. The research literature was used as an initial guide followed by an examination of software vendor websites and site visits to several universities to learn from the experiences of others. The key criteria in this search were that the components: 1) be generally available and not require special hardware environments, 2) be reasonably priced, and 3) not require excessive technical skills or programming on the part of the instructor.

This search identified three key tools that consistently appear in successful implementations. These tools are screen capture software, concept mapping software, and hardware to allow the instructor to use a stylus to "write" on the computer screen (i.e., a tablet computer or pen tablet connected to a computer). With these components, the instructor can digitally capture class lectures and special demonstrations, design graphical non-linear content navigation screens for the Internet, and provide rich feedback through electronic "ink" and audio annotations on electronic documents. Interestingly, while several implementations were found to have used combinations of two of these tools, none were found to have utilized all three; so the new blended design addressed by this paper appears to be unique in the research literature.

Other components were also identified as potentially useful. These were grouped into the categories identified above and are described in Table 1. In all but two cases, these components meet the search criteria concerning price, availability, and ease of use.[1] Thus, the blended architecture design is generally applicable and reasonably could be constructed and used by non-technical faculty.

Table 1: Blended Course Architecture Components and Descriptions.

Category	Component	Functional Description
Class Administration	*Online Syllabus	Class rules and schedule for the semester available online.
	*Announcements	General announcements for "between class" communication.
	*Anonymous feedback	Collect anonymous student feedback during the semester for mid-course corrections.
	*FAQ	Answers to frequently asked questions to quickly solve common problems.
	*Grade lookup	Allow students to look up their personal grades online.
	Distribution lists	E-mail distribution lists so students can contact each other for collaboration.
	Virtual office hours	Component to support online real-time chat with the instructor during posted hours.
	Personal learning plans	Online monitor and administration of student personal learning plans.
Content Capture	*Camtasia™ lecture	Component that records audio and video of the computer screen during lecture. Lecture can include PowerPoint™ slides, "ink" annotations, and other components.
	MS Producer™ lecture	Component that records and synchronized slides, audio, and video during lecture.
	MS OneNote™	Component used to merge and synchronize audio, video, handwritten text, typed text, and web content into single document that can be viewed over the Internet.
	*Interactive demos	Camtasia™ demonstrations produced to address a specific content topic.
Content Delivery	*Static content	Handouts and other static documents made available for download.
	*Augmented content	MS Office™ content with audio and/or "ink" annotations available for download.
	*Multimedia content	Streaming and file-based lectures available for online viewing on demand.
	*MindMap™ diagrams	Static and A/V annotated MindMap diagrams to structure and organize class content.
	*MindMap™ documents	Content documents attached to the MindMap™ for convenient student download.
Navigation	*Graphical content map	A "clickable" image displayed on the website used to navigate directly to different categories of content. Supports non-linear content access. The same content may be represented multiple times in different grouping to promote multiple modes of learning.
	*Traditional navigation	Standard hierarchical and direct hyperlinks available through the website to support linear content access.
Knowledge-	*"Wiki" topics	Personal and public "Wiki" documents used to promote collaborative learning.

Building	*Web research	Utilize Internet resources for individual and group research projects.
	Course module build	Students build topic course modules with Camtasia™ or similar product to add to the class knowledge-base.
	*Online tutorials	Utilize online tutorials for individual student learning and exploration.
	*Online simulations	Utilize online simulations to demonstrate complex environments.
	*Threaded discussion	Component to help students collaborate and communicate in group projects.
	Personal learning plans	Individual learning plans that combine learning modules and other educational resources to create a customized knowledge-building experience for students.
Assessment	*Textbook web quizzes	Students utilize textbook websites for self-quizzes.
	*Blackboard™ tests	Use Blackboard™ software to administer more formal tests via the Internet.
	*Camtasia™ quizzes	Embed quiz questions within a standard Camtasia™ lecture or learning module.
	Classroom clickers	Wireless clickers to perform quick student surveys and quizzes.
	*Tablet grading	Use Tablet PC or Pen Tablet to annotate electronic homework from students. Annotations can be audio or handwritten using electronic “ink.” Results are electronically returned to the student to provide richer feedback.
	Electronic portfolios	Electronic collection of student work made available over the Internet. Can be used as a learning resource for others or as an addition to the student’s résumé.

Architecture Implementation

The developmental research model assumes that solutions are developed through a series of iterative steps designed to systematically test implementations in a realistic environment. Given that the full architecture is too extensive to implement all at once, a subset of the most promising components were selected to be included in the initial pilot implementation. These components are notated in Table 1 with an asterisk (*) beside the name. Future iterations of the implementation will incorporate other components to determine their impact. In addition, a tablet computer was utilized in combination with these software components to provide the hardware platform needed to effectively implement the architecture.

To give a flavor of the architecture as implemented, Figure 1 shows the “clickable” CourseMap that was created with the MindMap™ software tool to help students navigate to the different components and content available in the system. When the user clicks on the branches of this map, control transfers to external web resources or to other clickable maps. An example of a second level topic map is shown in Figure 2. Intermediate branches of this map graphically expand when clicked upon. Terminal branches open the related content on the computer. This navigation scheme provides the benefits of non-linear content navigation along with support for multiple modes of learning.

Figure 1: Top-level CourseMap for web-based navigation.

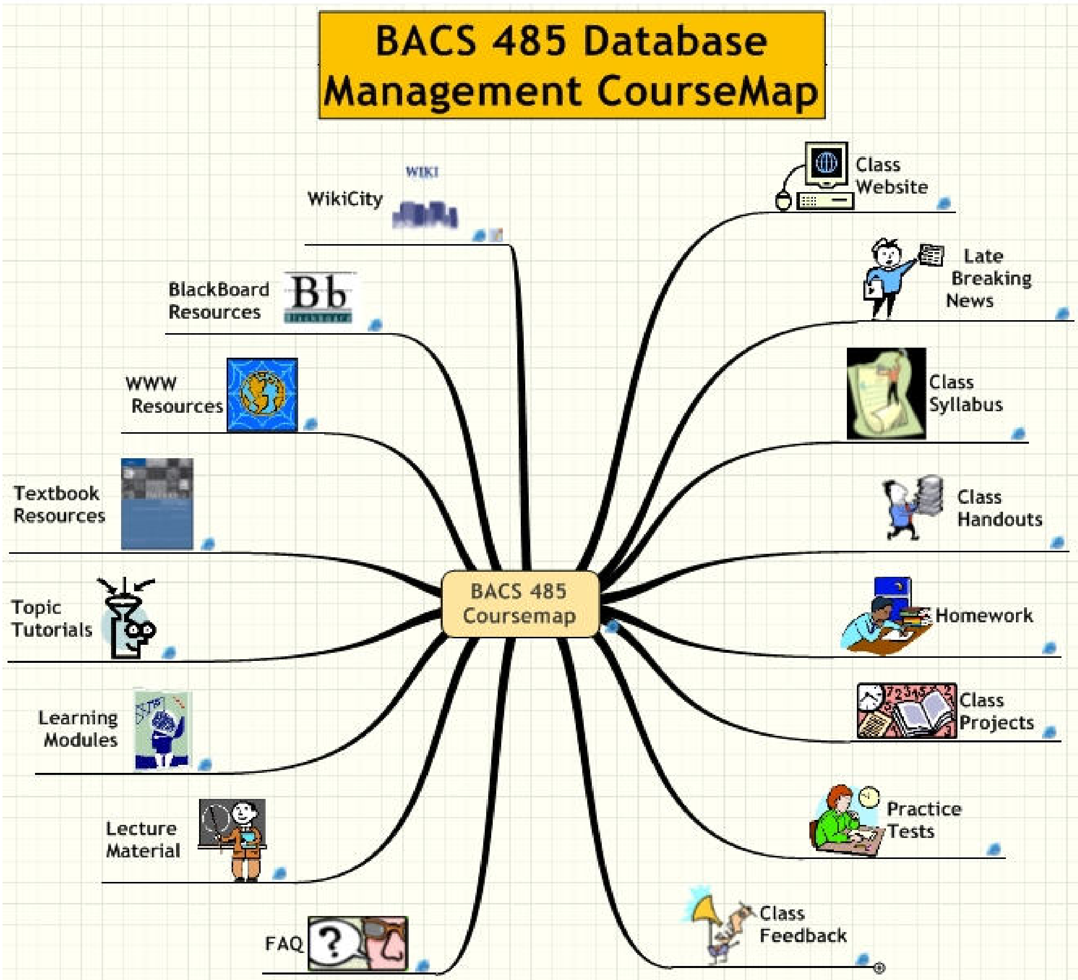
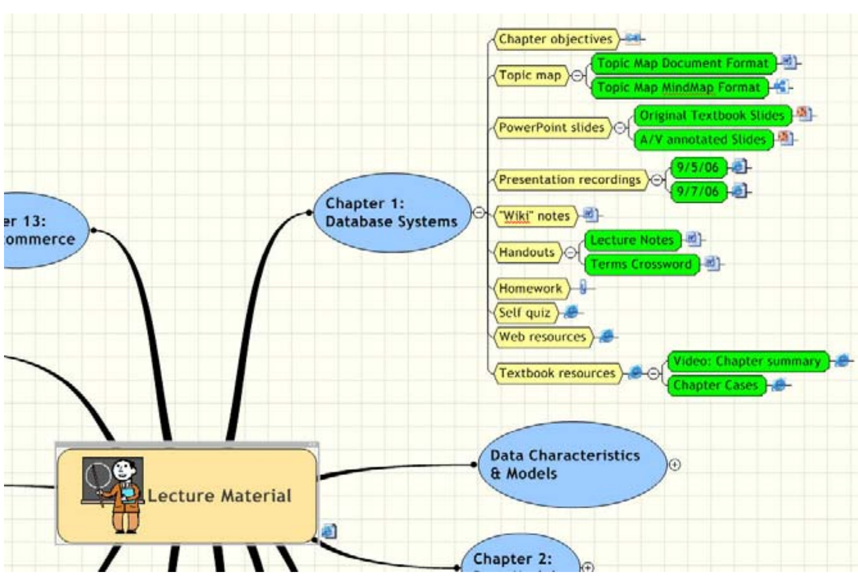


Figure 2: Chapter based content CourseMap.



EFFECTIVENESS OF THE ARCHITECTURE

A simple research survey was created to test student perceptions of the effectiveness of the main components in the new architecture. This survey was given to all students in the three sections of classes that used the new blended design. The methodology of this survey and the results it produced are discussed below.

Research Methodology

The research project was carried out in the context of the College of Business Administration within a state supported public University. The University has approximately 12,000 students of which about 1,200 are business majors. The demographics of the student population in the College of Business are best described as traditional, in that they are predominately in-state 18 to 24 year olds who are attending college for their first degree. Most students are full-time and live close to campus (so the results of the survey should not be overly skewed toward online technologies due to distance or job scheduling factors). In addition, all students in the college have access to high speed Internet through the computer labs and all have completed a prerequisite computer literacy class, so they are familiar with PC use and common software packages.

The classes chosen for the pilot implementation of the new blended architecture were two sections of a junior-level introduction to information systems class and one section of a senior-level database management class. These classes were chosen because they represent all five emphasis majors taught in the college and also provide a broad cross-section of technology aptitudes. In addition, all three sections were taught by the author, so the teaching style and presentation emphasis are consistent across the full sample.

Data concerning student preferences and opinions about the blended course architecture were collected through a paper-based survey that was distributed during class. A copy of the key questions from the survey instrument can be found in the appendix of this paper. Participation in the survey was anonymous and completely voluntary. In all, 65 surveys were completed and returned out of 75 that were distributed, resulting in an impressively high 86% response rate. Data from these surveys were coded into SPSS™ and analyzed using basic frequency analysis, cross tabs, and the chi-square goodness-of-fit statistic.

Survey Results

The results concerning the perceived usefulness of the key components of the new architecture are presented in Table 2. Figures 3 and 4 graphically represent the results of the survey questions concerning student lecture preferences. Finally, Table 3 reports on the student perception of the overall effectiveness of the blended learning environment. All results reported are significant at the p < .001 level using the chi-square statistic.

Table 2: Key Component Usefulness Cross Tabs.

Survey Questions		*N*	**Q2: Camtasia useful teaching tool** Not Useful 1 (%)	2 (%)	Neutral 3 (%)	4 (%)	Extremely Useful 5 (%)	χ^2 Goodness-of-Fit χ^2	*df*	*p*
Q1: Have used Camtasia	No	16	0.0	37.5	43.8	18.7	0.0	36.847	3	<.001
	Yes	48	0.0	2.0	4.2	52.1	41.7			
			Q4: MindMap useful lecture aid							
Q3: Have used MindMap	No	14	7.1	14.3	42.9	28.6	7.1	45.275	4	<.001
	Yes	51	0.0	1.9	5.9	47.1	45.1			

Figure 3: Student's top lecture preference [χ^2 (3, N = 65) = 55.16, p < .001].

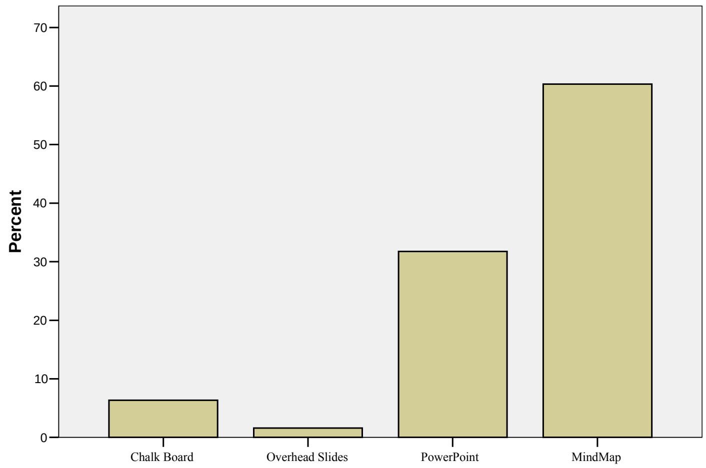


Figure 4: Student's top 2 lecture preferences [χ^2 (7, *N* = 65) = 215.98, *p* < .001].

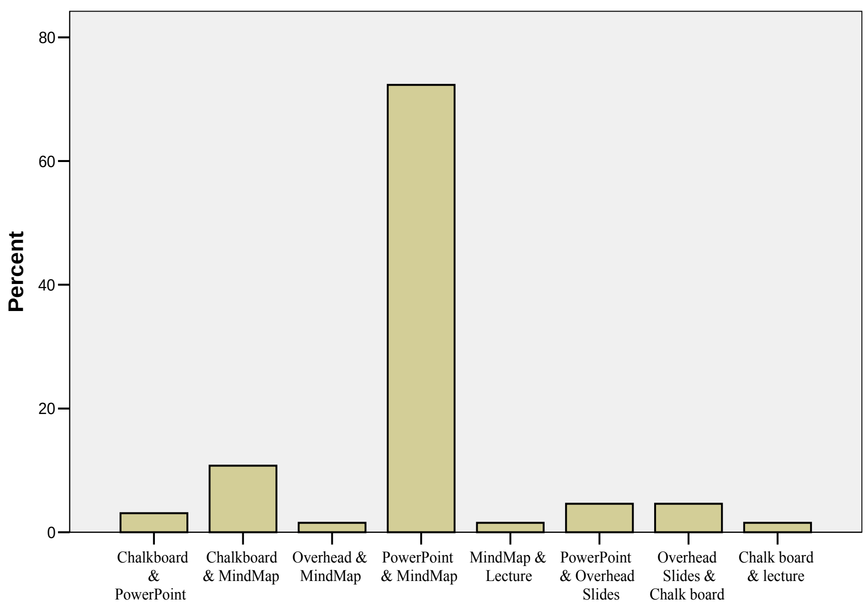


Table 3: Overall Effectiveness of Learning Environment χ^2 (3, *N* = 65) = 44.354, *p* < .001.

Survey Question	Not Effective		Neutral		Extremely Effective
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Q7: Effective learning environment	0.0	3.1	9.2	55.4	32.3

DISCUSSION

Of those students who returned the survey, 52.1% who had used the recordings stated that the Camtasia™ screen capture tool was "useful" while 41.7% said that it was "extremely useful." Taken together, this means that 93.8% rated it positively (i.e., above the "neutral" rating). This is compared to only 2% who rated it less than "neutral." Students who had not used the recordings had a less favorable impression with only 18.7% giving the package a positive rating. These results are segregated in this way because students who did not use the recordings are less informed as to the usefulness of the tool. Thus, their opinions are not co-mingled with those of more informed students. An implication of these results is that not only do an overwhelming percentage of students find the Camtasia™ screen recordings useful, but the attitudes of those who use it are radically different from those who choose not to use the component.

The second half of Table 2 shows that 92.2% of the students who used MindMaps™ as a lecture aid rated it positively, while only 1.9% rated it negatively (i.e., below "neutral"). As before, students who did not utilize the tool had a different opinion. Only 35.7% rated the tool positively while 21.4% rated it negatively. Interestingly, 42.9% rated MindMaps™ as "neutral" even though they had never used the concept maps. As before, these results imply a very positive student opinion about the technology component and a distinctly different opinion by those who actually use the tool. However, they also indicate a greater willingness to view the product in a positive light (or at least, a "neutral" light) than was present with the Camtasia™ component.

Figures 3 and 4 graphically show the results of the survey questions concerning student lecture preferences. The intent of these questions was to determine if students felt that the new MindMap™ component added anything positive to the classroom experience. As is evident from Figure 3, students were impressed with the MindMap™ tool, with 60.3% selecting it as their top lecture aid. The second place lecture aid was PowerPoint™ slides (31.7%). Thus, a new technology component (i.e., MindMaps™) and a more established technology tool (i.e., PowerPoint™) easily beat the traditional teaching components of pure lecture (0.0%), overhead transparencies (1.7%), and chalkboard work (6.3%). Even stronger support for technology components is evidenced in Figure 4 where 72.3% of the students selected the combination of MindMap™ lectures with PowerPoint™ slides. This is significantly more support than either tool rated when combined with any other tool; thus, a strong synergistic tool set is evidenced by these results. The implication of the results from these two survey questions is that students appreciate the new technology components over more traditional lecture techniques and would voluntarily select them if given a choice.

The final survey question concerns student perceptions of the overall effectiveness of the blended learning environment. The results in Table 3 show that 55.4% of respondents believe that the blended environment is "effective" while 32.3% rate it as "extremely effective." When combined, this means that a very strong 87.7% of responding students believe that the environment is (at least) "effective." Only 3.1% had a negative opinion of the environment. The implication of this is that students like the blended learning architecture as it exists in the pilot implementation and believe that it creates an environment conducive to learning.

CURRENT LIMITATIONS AND FUTURE RESEARCH

The most obvious limitation to the current project is that the results of the survey are based on student perceptions of effectiveness, not objective evidence of improvement. In addition, the survey does not precisely identify which components contribute the most to the overall effectiveness of the learning environment. Some justification for these limitations can be placed on the developmental research model that was employed. This model encourages prototyping and experimentation over well planned hypothesis testing. In the early stages of a project, this often creates weaker results than would be generated by a standard empirical experiment. However, it is a limitation so future work on this project will attempt to correct it by devising a way to measure actual learning in the environment as compared to a more traditional classroom. Future versions of the student survey will also include questions with "finer granularity" to help identify the most effective components. Some of these questions will be more open-ended and qualitative in nature so, for example, it will be possible to determine in what situations students felt that MindMap™ and Camtasia™ worked better and why they felt that way.

A second limitation of the project is that the results do not include data on the full architecture as initially conceived and described in Table 1. This was intentional and is, once again, justified by the developmental research model. This model works best when multiple implementations are iteratively tested and refined. The next phase of this project will incorporate several new components into the blended course design. It is hoped that these inclusions, along with the survey changes mentioned above, will produce an even more effective course design.

The final limitation of note involves the sample size of the survey. A larger sample size is needed to ensure the validity of the statistical results and hence the broad applicability of the architecture. The larger sample size would also allow other, more powerful, statistical tools to be applied to the data. This will be addressed in the next phase of the project. In this planned phase, multiple sections of classes taught by several instructors will utilize the course architecture. This will greatly increase the population of students involved in the experiment and will have the added benefit of determining if the architecture is equally effective across a range of classes, topics, and instructors. To provide an experimental baseline, at least one section will continue to be taught using more traditional methods. In this way, a valid comparison will exist to measure the actual improvement that occurs within the environment. In addition, an instructor oriented survey will be developed to determine how the new technology components were actually integrated into the classroom. This will help to identify those practices that are most effective in the implementation of the architecture.

SUMMARY

University-level teaching has become much more complex with the advent of powerful personal computers, inexpensive software, and the Internet. These technologies have made possible new modes of blended education that are potentially much more effective than the traditional approaches. Unfortunately, most university-level instructors are not technology experts, so they are forced to learn by trial-and-error which technology components are effective in an actual classroom setting and which are not. This project attempted to mitigate this situation by creating a blended course architecture that combines the best of traditional and online education. This architecture was designed using information gathered from the research literature, software vendors, and the experiences of practitioners. A pilot implementation of the new architecture was applied to three sections of university-level courses to determine student perceptions of its effectiveness.

The results of the student survey are very positive. Of the 65 students who responded, 55.4% rated the new blended architecture as "effective" while 32.3% rated it as "very effective." Specific key components within the architecture also rated positively. In particular, 93.8% of the students who reported using the Camtasia™ lectures perceived them to be "useful" or "very useful." Similarly, 92.2% of students who used the MindMap™ tool perceived it to be a "useful" or "very useful" learning aid. Finally, the results show that 60.3% of the students would select MindMaps™ as their preferred lecture aid over the more traditional lecture tools, while 72.3% chose the combination of MindMaps™ and PowerPoint™ slides as their top two lecture aids.

Research on this project will continue. Future iterations of the architecture will include other technology components and a broader classroom implementation to generate a better picture of which components are most effective and the range of environments over which the architecture works. The end result of this process will be a well-defined, blended course architecture that creates effective learning environments and can be applied easily by non-technical instructors.

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APPENDIX[2]

Questions in this survey refer to the usefulness of Internet based components used to augment this specific course. This survey is completely voluntary and anonymous.

1. I used the Camtasia based lectures provided by the course web-site.

No ☐ Yes ☐

2. I believe that the Camtasia lectures available through class web-site are ______ useful.

Not Useful- - - - - - - - - - - - - - - - - - -Neutral- - - - - - - - - - - - - - - - - - -Extremely Useful

☐ ☐ ☐ ☐ ☐

3. I used the MindMaps provided by the course web-site.

No ☐ Yes ☐

4. I believe that using MindMaps as a lecture aid is ______ useful.

Not Useful- - - - - - - - - - - - - - - - - - -Neutral- - - - - - - - - - - - - - - - - - -Extremely Useful

☐ ☐ ☐ ☐ ☐

5. Given the choice between the following lecture formats, I prefer ______ (Select **ONLY ONE**).

Strictly Lecture (no visual aids)	Traditional chalk board	Overhead slides	PowerPoint lecture	MindMap lectures
☐	☐	☐	☐	☐

6. If I could choose a combination of lecture formats, I would prefer _____ and ______ (Select **ONLY TWO**)

Strictly Lecture (no visual aids)	Traditional chalk board	Overhead slides	PowerPoint lecture	MindMap lectures
☐	☐	☐	☐	☐

7. Overall, how effective would you say the combination of in-class and web-based resources provided by this class are?

Not Useful- - - - - - - - - - - - - - - - - - -Neutral- - - - - - - - - - - - - - - - - - -Extremely Useful

☐ ☐ ☐ ☐ ☐

[1] The exceptions involved the dynamic MindMap™ personal learning plans. These would require programming, as this capability does not exist in the basic package. Consequently, exploration of this component will be pursued in a separate research project.

[2] In addition to these questions, the full survey also asked the student for basic demographic information such as gender, major, and classification (e.g., Freshman, Sophomore).