The Effectiveness of an On-Line Graduate Engineering Management Course

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Abstract

In the summer of 1997, the Engineering Management Department of the University of Missouri-Rolla's (UMR) began offering its first Internet-based graduate level course. This course, Advanced Production Management, was designed to utilize a combination of Internet-based tools, such as EMail and Chat rooms to create a alternative means for the delivery of course material. This paper will draw these following conclusions from more than a year of research, which included over 100 students in six different course offerings. First, the Internet-based students performed equally as well as the control group students. Second, students tend to have exaggerated time requirement expectations for Internet-based classes. Third, students tend to have positive course effectiveness experiences. Fourth, students tend to be very skeptical of electronic lectures but their experiences are positive. Fifth, learning styles play a role influencing student expectations regarding Internet-based education. This influence is especially strong in student course time expectations and both the effectiveness and satisfaction of the use of EMail and Chat rooms.

Overview of Research

UMR has conducted a yearlong effort to determine the effectiveness of Internet-based technology for "improved learning" in engineering education. To examine the effectiveness of Internet-based education, many facets were analyzed including class performance, fulfillment of student expectations, and effects of student backgrounds. To assist in evaluating learning effectiveness, the following four areas were investigated: a) the time required for the course, b) the overall learning experience, c) the effectiveness for aiding course material comprehension using specific instructional tools including video lectures, EMail, and Chat room, and d) level of satisfaction related to specific tools utilized by the instructor including video lectures, EMail, and Chat room.

Course Background

The Engineering Management Department's Advanced Production graduate level course used in this research provides an overview of such topics as decision theory, forecasting, and total quality management. Prior to the introduction of this Internet-based course, the Advanced Production course was taught simultaneously via traditional on-campus classroom instruction and over satellite broadcast through the National Technological University (NTU). Unlike these formats, this Internet-based course utilizes an Internet site where its "homepage" resides. The homepage contains links to the class syllabus, assignment lists with instruction, grading policies, the class Chat room, class lectures and quizzes.

The lecture and quiz modules available over the Internet were created using Lotus ScreenCam software. These modules, containing both video and audio information, resemble a Microsoft PowerPoint presentation with associated audio instruction. In addition, both audio and visual components of each presentation are synchronized with prerecorded cursor movements. Most impressively, students are able to stop the lecture or quiz at any time and repeat if necessary. During the semester, there are two group assignments for which students have the option to communicate with each other either electronically or face-to-face.

On the first day of class, the instructor meets with the students at an on-campus site to provide an introduction to the course format and the Internet-based tools used for this course. There is no further meeting of the Internet-based class until the last day of the semester when the final examination is administered. Interactions between students and instructor and among students are encouraged to be done electronically via the Chat room or EMail.

Research Objectives and Methodology

The three major objectives of this research were the following. First, to determine whether or not the educational tools, both Internet-based and traditional, fulfilled the subjective expectations of the Internet-based course student in respect to: a) the time required for the course, b) the overall learning experience, c) the effectiveness for aiding course material comprehension using specific instructional tools and d) level of satisfaction related to specific instructional tools. Second, to determine whether the Internet-based course students and traditional class students perform equally as well as determined by the difference between the pre-test and post-test results, in respect to: a) between the five Internet-based classes and traditional class and b) within the Internet-based classes. Third, to determine whether student demographics, learning style preferences, and computer familiarity backgrounds had an effect as to the student expectations and experiences in respect to: a) the time required for the course, b) the overall learning experience c) the effectiveness for aiding course material comprehension using specific instructional tools and d) level of satisfaction related to specific instructional tools.

A total of six classes of students were involved in this research. There was one traditional, in residence class serving as a control group and five Internet-based classes. See Table 1. The first class examined commenced in August 1997 with the last class concluding in July 1998.

Instruction Type	Class Dates	Number of Students
Internet-based Class 1	Aug. 97 - Oct. 97	19
Internet-based Class 2	Nov. 97 - Feb. 98	19
Traditional Course (Control Group)	Nov. 97 - Feb. 98	15
Internet-based Class 3	Jan 98 - Apr. 98	22
Internet-based Class 4	Apr. 98 - July 98	20
Internet-based Class 5	Jan. 98 - May 98	12

Table 1: Schedule of Research

Each student in the Internet-based class and traditional class completed three sets of surveys and tests; 1) the Initial Student Demographic and Computer Background, and Expectations surveys, 2) the Mid-Term Student Evaluation and Kolb's Learning Style Inventory, and 3) the Student Final Experience Survey and Felder-Silverman Index of learning Styles.

Learning Styles

Learning styles were defined by Kolb (Kolb 1981) as a systematic method to assess how individuals learn information. The experimental learning theory as defined by Kolb provides a model of one's learning process, consistent with the existing theories of human cognition and the stages of human intellectual development (Kolb 1976). According to the experimental learning model, the learning process consists of four interrelated stages; Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation.

The Kolb Learning Style Inventory (LSI) is based on this learning model (Kolb 1976). It has become a popular tool used to categorized four distinct types of learners; accomodators, divergers, assimilators, and convergers, one for each quadrant of the learning model. These learning types are based on combinations of the four learning abilities as depicted in Figure 1. Depending on which quadrant the student falls into for a specific learning situation, he or she will display a distinct set of learning characteristics.

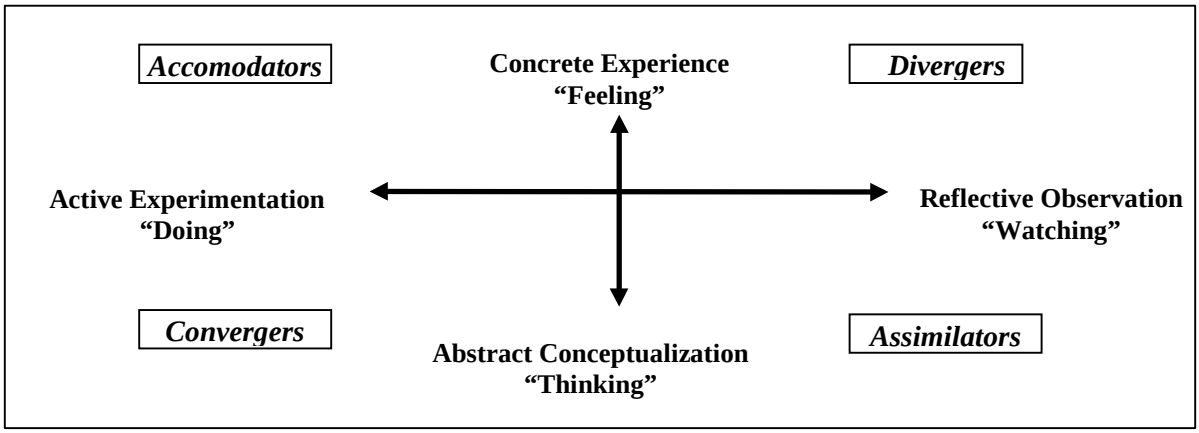

Figure 1: Kolb Learning Styles (Kolb 1976)

More recently, Felder and Silverman developed another learning styles assessment tool, named the Index of Learning Styles (ILS). In contrast to Kolb's LSI which was developed to assess all students regardless of academic major, Felder and Silverman's was developed mainly to assess the learning styles of engineering students. Instead of two dimensions, as in Kolb's LSI, the Felder and Silverman classify students along five dimensions as shown in Table 2. Unlike Kolb's LSI, the ILS is a less established and statistically validated tool and is currently under evaluation (Felder, 1996).

	Attributes			Attributes	
1	**Sensing**	Concrete, practical, fact and procedures orientated	**Versus**	**Intuitive**	Conceptual, innovative, theories & meanings orientated
2	**Visual**	Prefers visual representations, i.e. charts	**Versus**	**Verbal**	Prefers written or spoken explanations
3	**Inductive**	Prefer presentations that go from the specific to the general	**Versus**	**Deductive**	Prefer presentations that go from the general to the specific
4	**Active**	"Doing"	**Versus**	**Reflective**	"Thinking"
5	**Sequential**	Linear, orderly, learn in small increments	**Versus**	**Global**	Holistic, system thinkers, learn in large steps

Table 2: Felder-Silverman Learning Styles Model Student Classifications (Felder, 1996).

Final Results

The following graphs and tables summarize the more significant finding found in this study. First, as shown in Figure 2, the Internet students performed slightly better when examining the difference in their individual pre-test and final exam scores. Since there was no significant difference in means, one can conclude from the evidence that the control group and Internet students performed equally as well. Therefore, the Internet technology did not hinder the learning process.

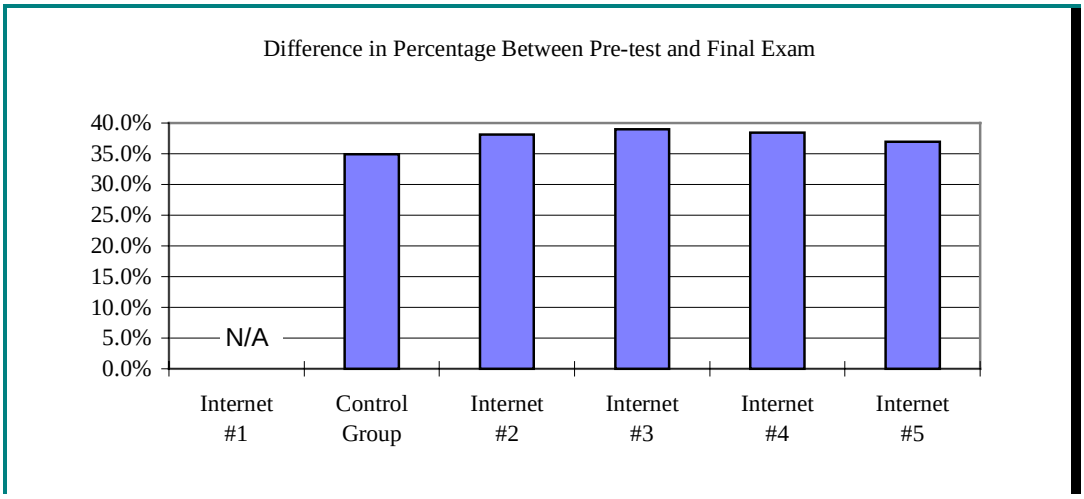

Figure 2: Difference in Percentage Between Pre-test and Final Exam

Second, the time requirement for the course expectations of the Internet students were actually more than experienced for all five classes examined, Figure 3 below. In reviewing an additional statistical measure for the Internet classes, the Pearson Correlation value indicates correlation between variables was significant to 0.05. Thus, from the data, a student's initial expectations as to time required was highly correlated, had an effect on, a student's actual experience. Therefore, student initial expectations play a major role in determining their final experience.

From Figure 3, one may note all classes had varying degrees of time expectations and experiences. The within-subject effect, had a significance of 0.022. An inconsistent explanation of an Internet-based course or an unequal level of prior course knowledge at the preliminary survey administration class could possibly explain this observation.

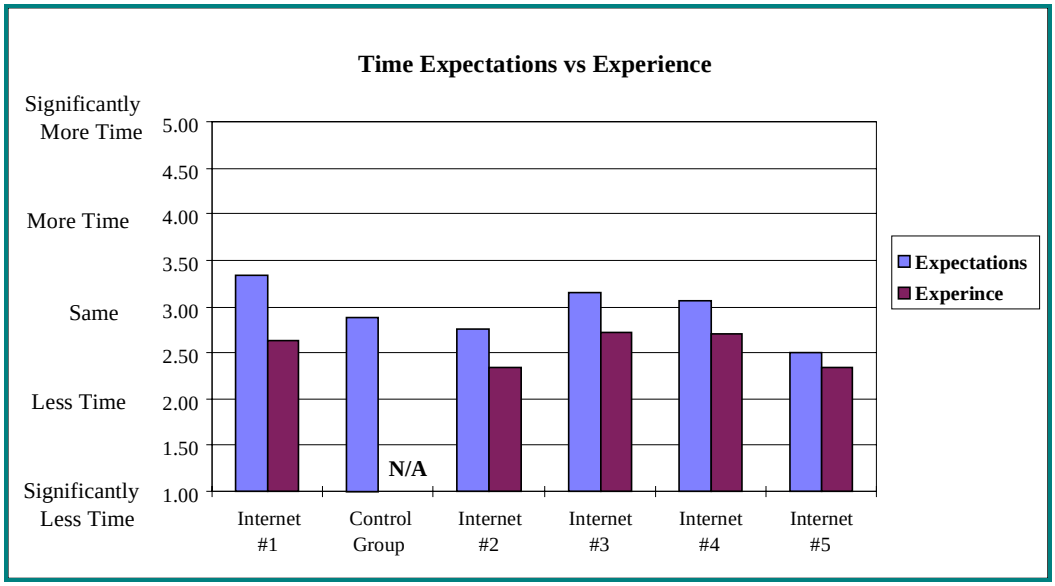

Figure 3: Time Expectations vs Experience

Third, the overall learning effectiveness expected for the course was fulfilled in all but the last Internet course, Figure 4. In reviewing an additional statistical measure, the Pearson Correlation value was significant to 0.05. Thus, from the data, a student's initial expectations as to the overall learning effectiveness were highly correlated to his or her actual experience.

Note, that all classes had different expectations and experiences regarding the overall effectiveness of an Internet based course. The difference in means for the expectations had a significance value of 0.012. The within-subject effect when examining both the expectations and experiences, had a significance of 0.01. As to different expectations, this could possibly be explained by student prior knowledge of the course from past students and course material administered before the first day of class.

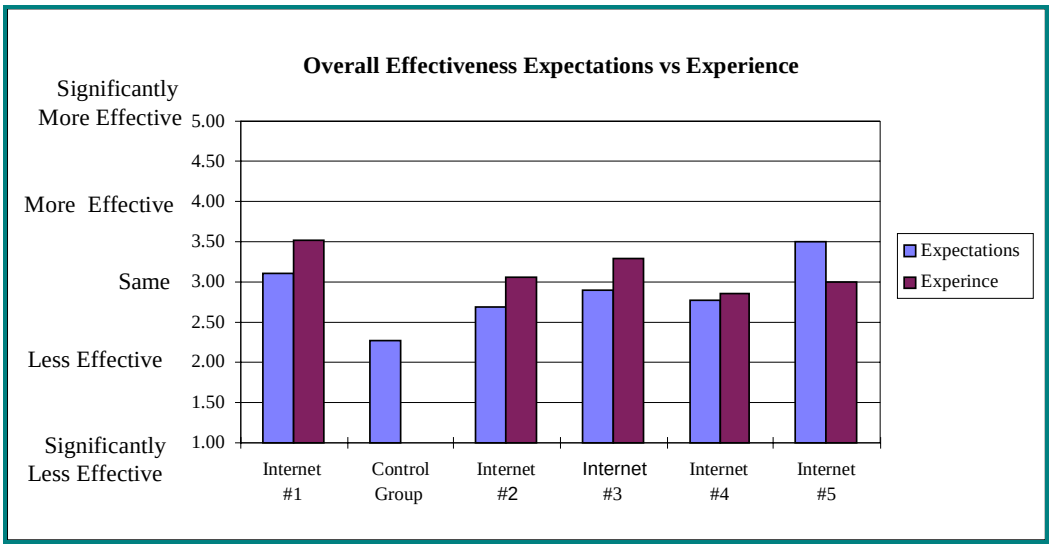

Figure 4: Overall Effectiveness Expectations vs Experience

Fourth, the overall electronic lecture effectiveness expected for the course seemed to be less than actually experienced, Figure 5. In reviewing the Pearson Correlation value, there was no significant value to conclude a correlation between expectations and experiences. From the graphical data, one can conclude that the electronic lectures provided a worthwhile and effective learning experience.

Note, the control group had lower expectations of an Internet based course as compared to the Internet-based student. When the expectations were analyzed, there was a difference in means for expectations, significant to 0.01. Once again, this could possibly be explained by the lack of explanation and prior knowledge at the time of the preliminary survey administration.

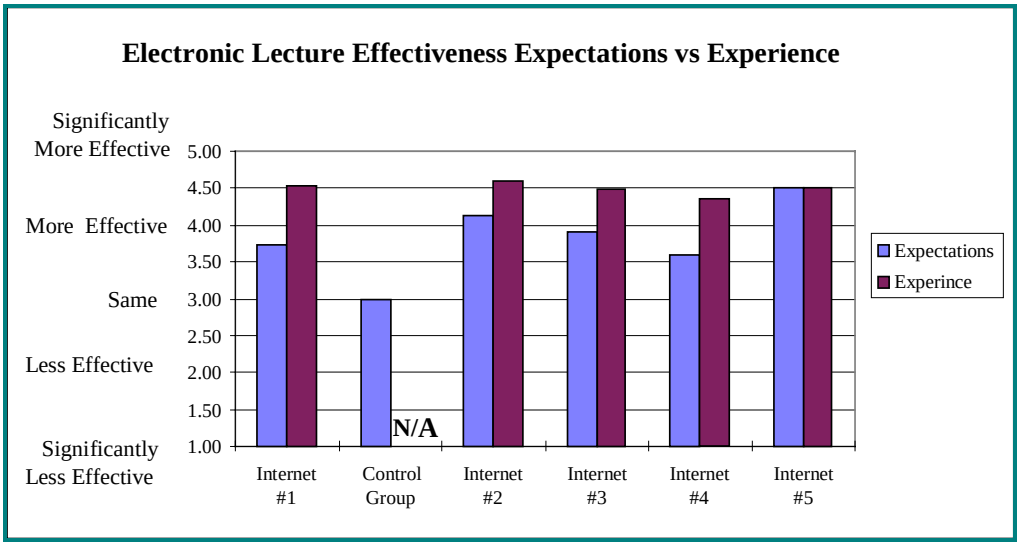

Figure 5: Electronic Lecture Effectiveness Expectations vs Experience

Fifth, Tables 3 and 4 provide additional insight into what was observed regarding the influence of learning styles. From Table 3, one can conclude that those students whose learning styles reflected higher abstract conceptualization and active experimentation values performed better on course examinations. In regards to the communication media used in this course, students who had higher concrete experience values also had higher expectations than those with lower values. In addition, students with higher reflective observation dimension values had more optimistic expectations than students with lower values, for both satisfaction and effectiveness of EMail and the Chat room.

Kolb Learning Style Dimension (LSI)	**Correlated Variable**	**N**	**Pearson Correlation Value**	**Pearson Correlation Significance**
Abstract Conceptualization 0 = lowest, 48 = highest	Pre-test and Final Exam Difference	86	0.252	0.05
Active Experimentation 0 = lowest, 48 = highest	Pre-test Scores	86	0.295	0.01
Concrete Experience 0 = lowest, 48 = highest	Expected EMail Effectiveness	104	0.294	0.05
	Expected EMail Satisfaction	104	0.290	0.01
Reflective Observation 0 = lowest, 48 = highest	Subjected PC Experience	104	0.223	0.05
	Expected EMail Effectiveness	104	0.352	0.01
	Expected EMail Satisfaction	104	0.269	0.01
	Expected Chat Room Effectiveness	104	0.269	0.01
	Expected Chat Room Satisfaction	104	0.259	0.01

Table 3: Kolb Learning Styles Correlations

From Table 4, one can conclude that those students with higher in higher active reflective learning style values had better learning experiences than those with weaker values. In regards to student visual-verbal values, students who were higher in this dimension had higher pre-test scores, greater time expectations and experiences, and a greater difference between the pre-test and final examination. In addition, those students who had higher sequential global values, had more optimistic expectations than students with lower values, for electronic lecture effectiveness and both satisfaction and effectiveness of the use of EMail.

Felder-Silverman Learning Style Dimension (ILS)	Correlated Variable	N	Pearson Correlation Value	Pearson Correlation Significance
Active Reflective 1 = Highly Active 2 = Moderately Active 3 = Mildly Active or Reflective 4 = Moderately 5 = Highly Reflective	Learning Experience	105	0.281	0.01
Visual Verbal 1 = Highly Visual 2 = Moderately Visual 3 = Mildly Visual or Verbal 4 = Moderately Verbal 5 = Highly Verbal	Pre-test Scores	87	0.325	0.01
	Time Expectations	87	0.221	0.05
	Time Experience	105	0.196	0.05
	Pre-test and Final Exam Difference	87	0.281	0.01
Sequential Global 1 = Highly Sequential 2 = Moderately Sequential 3 = Mildly Sequential or Global 4 = Moderately Global 5 = Highly Global	Expected Electronic Lecture Effectiveness	106	0.194	0.05
	Expected EMail Effectiveness	106	0.248	0.05
	Expected EMail Satisfaction	106	0.221	0.05

Table 4: Felder-Silverman Learning Styles Correlations

Conclusions and Recommendations

This research supports several conclusions. First, the Internet-based students performed equally as well as the control group students. Therefore, the Internet did not hamper the learning process for the Internet-based students. Second, students tend to have exaggerated time requirement expectations for Internet-based classes. One possible explanation could be that these students have reservations about the time required to learn the necessary technology in addition to the course material. Third, students tend to have positive overall course effectiveness and satisfaction experiences in an Internet classroom format. Fourth, students tend to be initially skeptical of electronic lectures but experiences prove positive. However, the communication media such as Chat room and EMail must be investigated more closely for improved effectiveness. Fifth, learning styles play a role influencing student expectations regarding Internet-based education. This influence is especially strong in student course time expectations and both the effectiveness and satisfaction of the use of EMail and Chat rooms.

The authors recommend several actions for instructors investigating teaching over the Internet. First, it is extremely critical for the instructor to fully explain the details of the course in a positive manner. This should calm student fears and provide a more effective learning environment. Second, the instructor must create well structured, easy to follow and use, electronic lectures. Third, learning styles, which seem to effect student expectations regarding Internet-based tools of communication, must be addressed if the course is to be successful for all students.

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