

## **A Web Based Courseware Preparation Guide Using a Syllabus Based Teaching/Learning Framework: for an Engineering Statistics Courseware**

G. Bengu, and NJCMR-MPIDS Multimedia Production Team:  
C. Liu, X. Tang, G. Erkavun, W. Zhang, L. Cao  
*Department of Industrial Engineering, Computer & Information Science  
New Jersey Institute of Technology.*

**Key words:** *Statistics, Engineering, Courseware Multimedia, Web based Education, Interactive, Quiz System Video Streaming, Assessment, Java Script, Java Applet, Agent Tech., Intelligent Learning Systems.*

### **Abstract**

In college education, more and more courses are embedded with multimedia and deployed as courseware over the Internet. How to apply a web based delivery system to further enhance teaching and create an effective learning/tutoring environment? A standardized, flexible courseware development framework built during this study offers a practical solution to the challenge of how to design, build, and deliver an integrated web-based tutoring system. The system has been set up as an example using relatively simple technologies to support traditional classroom courses. Authors believe that the development tools presented here are easily followed and can be recommended for those looking for a sustainable courseware system with relatively simple method of development. This paper also reviews valuable online resources and illustrates the adaptation of interactive systems that can be provided as hands on experiments. Additionally the example courseware and course assessment forms and results are integrated into the courseware to provide a Continuous Quality improvement. The quantified benefits of this approach to traditional classroom teaching are currently under study. The study is using both the formal and the objective evaluation results.

### **1. INTRODUCTION**

As we enter the 21st century, learning is progressively expanding beyond the traditional classrooms walls to our work and daily life. There is a demand for learning, from individuals and groups, virtually anywhere and all the time and —new technologies are helping to meet this demand. Today, students and practitioners alike are experiencing a digital world that is changing at an ever-faster pace that requires life-long learning to be productive. At the same time people more than ever remain virtually connected through telephone, the Internet, and other new technologies. How can these technologies be used to enhance and adapt the traditional methods of learning so that they are effective for the modern times? These are some of the fundamental challenges facing students and teachers alike in the digital age.

In this paper we address the challenge of using new technology to enhance a traditional engineering course. We introduce a flexible web-based teaching/learning framework that has been used to **enhance**/support/implement a traditional engineering statistics course. This web-based educational support system, developed by the Multimedia Production and Internet Delivery Studio (MPIDS) research group with the support of NSF<sup>1</sup> and NJCMR<sup>2</sup>, is enhanced with newly developed state of the art multimedia applications. It includes:

---

1 NSF-CCD Intelligent Learning System Development

- *Lecture notes* with slides as well as *detailed notes* that students can access before or after classes,
- *Printable students' handouts*,
- *An interactive quiz system* which allows students to submit homework online,
- *A review of sample questions and answers* to familiarize the students with statistical applications for various situations
- *WebChat / Web-board and Group E-mailing system* to further enhance the group communications and teamwork which are required as part of semester projects
- *Video-audio aids* for case studies to enhance semester projects

Students' feedback documents that they very much favor the availability of online notes and exercise problems/solution and are motivated with the use of interactive systems, on-line video and related industrial quality software applications in their projects. To help students further in learning the

- *Screen captures of hand-on training sessions* are streamed as digital video
- *Software online manuals* are also linked to the courseware
- *Software account application* is all Web based and can be reached by the students through their courseware
- *Online resources* such as powerful interactive applets and animations offer hands-on demonstration of the statistical theory
- *Assessment forms* both for the courseware as well as for the course are systematically made available to students to capture their feedback for continuous quality improvement.

The aim of this courseware is to present an introductory statistics course in a multimedia format to further enhance the traditional classroom education – so that using the power of computers we can enrich, prepare, and assist the students both in and out of their classroom. The courseware is designed for individuals who enroll in traditional undergraduate classroom education, and is accessible by the students in the school, home or at work via World Wide Web & the Internet with an authorization code. The authors observed that faculty and students had more opportunities to discuss real life case studies and collaborate to solve example problems when they are freed from continuously taking notes. However, a student still might feel the need to scribble on the handouts. Also author purposely encourages note taking when solving problems on the board.

Normally, in an effort to move to digital era, traditional classroom lectures are directly adapted for Distance Learning by the Institute. We have chosen to follow a path that at first converts the traditional lectures to electronic form, assess the performance of the courseware and its components, and then debug and revise it so that it will eventually be ready for distance learning. Distance Learning students are at more risk if the efficacy of the courseware is not assessed. This approach minimizes the risk to the students and familiarizes faculty to new technology by adding electronic capability step by step as progressively adapted based on the feedback obtained by the

students and developers. Authors believe that, the assessment must be a permanent component of the courseware for Continuous Total Quality Improvement.

## 2. Course content and Choice of Multimedia Technology

At present, the on-line courseware for “Probability & Statistics” is used both for undergraduates and graduates as a bridge course. The major subjects covered are:

- Probability
- Probability distribution
- Statistical measures describing data
- Frequency distributions
- Sampling parameter estimation
- Hypothesis testing
- Analyses of variance
- Regression analyses

Table 1 shows the main course information.

**Table 1. Course Information**

Course title	Probability & Statistics for Engineers
Credits	3
Prerequisite	Math 222: Basic algebra and methods for solving ordinary differential equations, Laplace transforms, numerical solutions, and series solutions. Basic familiarity with computers.
Course Content	Statistical analysis techniques and their applications. Topics include: the statistical measures describing data, frequency distributions, probability distributions, sampling parameter estimation, hypothesis testing, regression analyses, and analyses of variance. Special emphasis is given to applications in industrial fields

### 2.1 Course Management

The regular classes are supported by the web-based courseware for students to read and study before the class or rehearse after the class. Students are asked to bring the printable handouts and calculators into the classroom. Students need to take notes only for details if needed, and spent the time saved in class exercises that are regularly completed for each subject. During exercises students initiate the problem solutions by themselves and **collaborate with the group members** to complete the solution. Each group representative presents the solution of the group – this fosters team competition. It has been observed that students take this event seriously and do their best to win as a team.

### 2.2 Courseware Components & Multimedia Technology

Listed by chapter, for each of the 14 weeks, the courseware contains Lecture Presentations, Printable Handouts of the Presentations, Detailed Notes, Chapter Summaries, Review of Problems and Solutions for each Section of a Chapter, List of Weekly Assignments, Streamed

video for real life case studies, Advanced subjects notes, and Interactive homework for self assessment (Table2 Courseware Content).

**Table 2. Courseware Content**

<b>COURSEWARE CONTENT</b>	<b>MAIN FUNCTION</b>
<b>Lecture Slides &amp; Printable Handouts</b>	Facilitates the instructor to have lectures; students could use them for review/rehearse.
<b>Video Streamed On-Line Lectures</b>	Enables the off-campus study, without limits with schedule or location (for Distance Learning version).
<b>Problem Review &amp; Solutions</b>	Strengthens what have been learnt, and gives the students an opportunity to analyze and solve practical problems in various applications.
<b>Interactive Homework</b>	Enables the students to have self-test and know what should be reinforced further.
<b>Video Streamed Case Studies</b>	Illustrates various applications of statistics and initiates ideas as semester projects with guidelines to follow.
<b>Group Communication Tools</b>	Unites the class in which members are in different locations, so that they can share their ideas and discuss in forum just like in one classroom. i.e., used for <i>Study Groups</i> and <i>Group Projects</i>
<b>Use of Industrial Standards Software</b>	Provides hands on computer applications. Introduction to SAS acquaints the students with the most common software
<b>On-Line Hands on Training</b>	Computer Screen Captures for Software Training

Group communication, web conferencing and other communication tools facilitate the teamwork to complete the semester projects. Streamed video is used to present real life case studies to provide examples for semester projects. Students are also motivated to use industrial quality commercial software in their projects. To help students in learning the use of software, screen captures of hand-on training sessions are also streamed as digital video and, in addition, software online manuals are linked to the courseware. Software account application is all Web Based and can be reached by the students through their courseware. Online resources of the web such as powerful interactive applets and animations offer hands on demonstration of the statistical theory. Assessment forms are made available online for students to use during the semester. The multimedia content of the courseware is summarized in Table 3.

### **3. Courseware Design and Delivery**

The preferred modality of the lecture delivery for this web-supported course is the “slide presentation.” Microsoft PowerPoint is used to create the lecture presentations due to its

**Table 3. Multimedia Content**

<b>Syllabus</b>	<b>MSWord</b> ( <i>Tables and Web Links</i> )
<b>Lecture Slides &amp; Handouts</b>	<b>PowerPoint &amp; Acrobat Writer</b> (pdf)
<b>Lecture Notes</b>	<b>MS Word with Equation Editor and Acrobat Writer</b> (pdf)
<b>Problem Review/Solution</b>	
<b>Interactive Homework/Quiz</b>	<b>Java &amp; Access/Oracle</b> ( <i>ODBC/JDBC/Servlets,Architecture</i> )
<b>Group Communication Tools</b>	<b>Egroup</b> (simple group mailing), <b>and Web board</b>
<b>Video Streamed Case Studies (for Semester Projects)</b>	<b>Video Streaming: Real Audio, Video</b>
<b>On-Line Hands on Training for Comp. Applications: Computer Screen captures as Digital Video to Illustrate Comp. Applications</b>	<b>Lotus Capture &amp; Real Player</b>
<b>Use of Computers for Statistical Analysis</b>	<b>SAS</b>
<b>Assessment of Web based Delivery of Course</b>	<b>Excel, HTML</b>

wide acceptance and compatibility. The Power Point slides are saved as pdf files (or html) and linked to the courseware. During lectures the course materials are accessed from Internet (or even from diskettes) using a computer with a Web browser. Usage of the courseware during the class familiarized students with the courseware design. It has also been observed that illustration of interactive experiments/games is a strong motivator for students to try the courseware themselves [<http://bengu-pc2.njit.edu/bengu/courses/statistics/SLIDES/Chap2/chap2.pdf>]

### 3.1 Course Syllabus Table

The Course Syllabus structure/framework is chosen as the main home page design. It is built using simple table format. The Course Syllabus serves as the main entry point to courseware and lists on one page all the material that may be accessed. The multimedia resources for a particular topic are grouped and listed on a single row. The Course Syllabus Table can be generated even using Microsoft Word and saved as a Web page, for example as *index.htm* (Front Page Web software is also very similar to Word). The lecture slides are then linked to the corresponding chapters of the course syllabus (see Figure 1). Course Syllabus structure is well established structure used both by the students and the faculty.

### 3.2 Copy and Password Protection for Courseware Slides/Web Site: Acrobat Writer/Reader or Java Script

**The instructors, who prefer to have some level of copy protection of the content and to prevent unauthorized use, can convert the files into “portable document format” (pdf) files (Figure 2).** Pdf files, which preserve the exact look and content of the original files, are viewable and can be copied/printed but cannot be edited/modified. Almost every file including the Power



# Probability & Statistics

TEXTBOOK | HOMEWORK | PROJECT | GRADING | LINKS | SAS | WEB BOARD | EGROUP | VIDEO | FAQ/INFO<sup>1</sup>

<b>Print Slides</b>			<b>Home work</b>	<b>Interactive Homework</b>	<b>Advance Topics</b>
<b>1</b>	<u>INTRODUCTION</u>				
	<u>DESCRIBING DATA SETS</u>	2.2 <i>Frequency Tables &amp; Histograms</i>			
		2.3 <i>Stem &amp; Leaf Plots</i>			
	<u>STATISTICS FOR DATA SUMMARY</u>	3.2 <i>Mean, Median, Percentiles</i>			
		3.5 <i>Standard Deviation &amp; Corr.</i>			
	<u>PROBABILITY</u>	4.2 <i>Probability, Conditional</i>			
		4.6 <i>Bayes Theorem, Summary</i>			
	<u>Midterm Exam Class Performance</u>	<i>Computer Software SAS Manual &amp; Assignments</i>		Case Study Videos	Course Assessment
	<u>DISTRIBUTION OF SAMPLING STATISTICS</u>	5.4 <i>Central Limit Theorem</i>			
		5.5 <i>Sample Proportion</i>			
		5.6 <i>Distribution of the Variance</i>			
	<u>HYPOTHESIS TESTING</u>	6.2 <i>Significance Levels, Unknown Variances, Dependency</i>			
	<u>ANALYSIS OF VARIANCE</u>	7.2 <i>ANOVA, One &amp; Two - Factor Analysis of Variance</i>			
	<u>Final Exam</u>	<u>Project Report Due</u>			
	<b>Grade Analysis</b>				



TEXTBOOK | HOMEWORK | PROJECT | GRADING | LINKS | SAS | Web Board | Egroup | Video | FAQ/INFO<sup>1</sup>



Figure 1. Course Syllabus

Point files can be printed in pdf file format as a simple print option. This requires Adobe Acrobat Writer Software to be loaded. Files with .pdf extension can be linked to web pages directly. In addition to this edit protection, pdf files also come with password protection, authors can define a password for students to access and view these pages. To view these files, students could download the free software called Acrobat Reader.

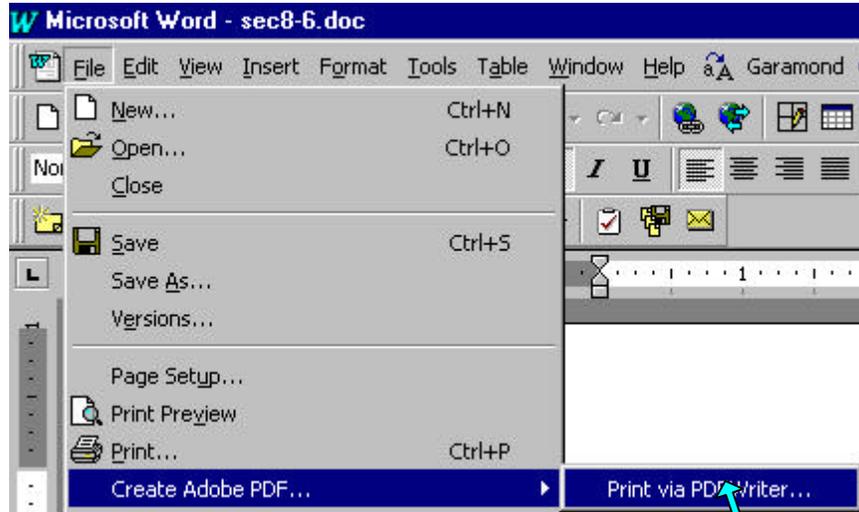


Figure 2. How to convert a file into PDF

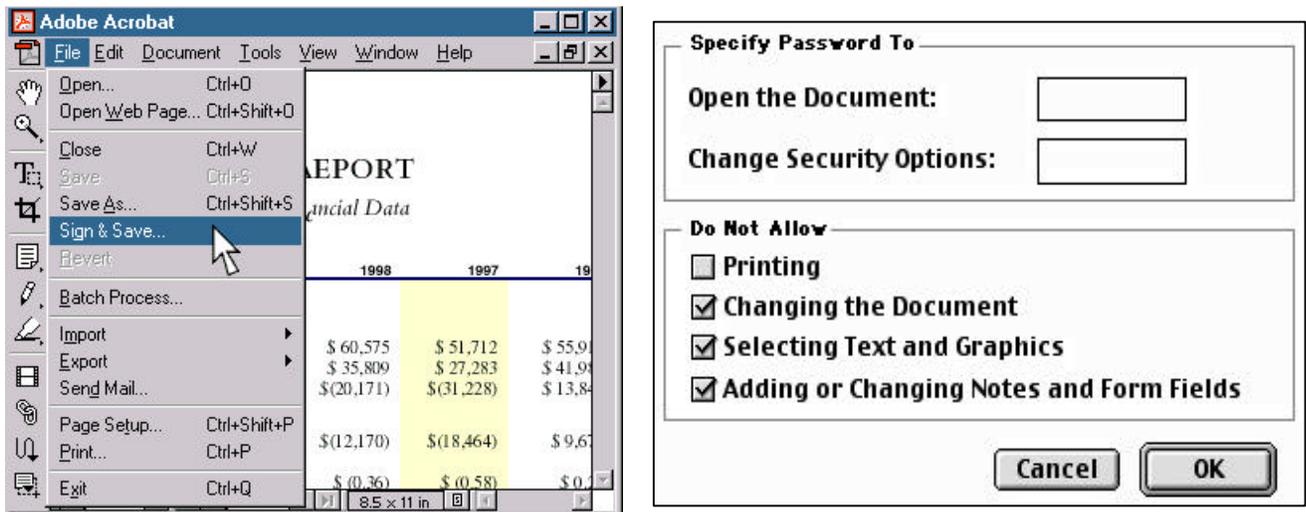
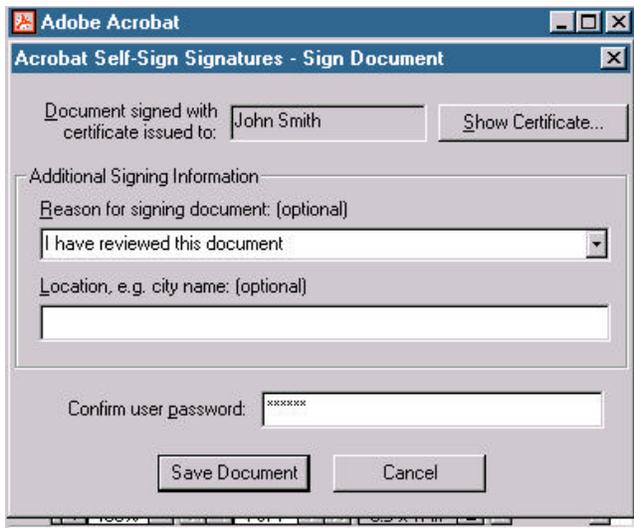


Figure 3a. How to add password to PDF files?

### 3.3 Printable Handouts for Students: PDF

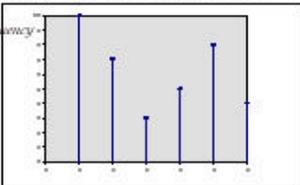
Most students prefer to have the handouts of the lecture slides where 2 to 6 slides are printed together in one page. They bring them into the classroom and scribble on during the lectures and exercises. Students can print Power Point lecture slides as handouts, but not the pdf files. To address this challenge, the authors also printed the pdf version of the handouts and link them to The courseware along with the slides (figure 4).



**Figure 3b.** How to add password to PDF files.

<http://bengu-pc2.njit.edu/bengu/courses/statistics/SLIDES/Chap2/Chap2print.PDF>

*If preferred, the instructor can provide a hard copy of handouts in various other ways, i.e. library reservation. Based on our assessment, students' preferences of handouts are in this order 1. Printed handout copies during lectures 2. Power points files for them to print 3. Printable pdf files. However, when power point files are made available then it has been observed that few students will make an authorized use of these slides, i.e. using for other class presentations.*

<p style="text-align: center;"><b>CHAPTER 2</b> <b>DESCRIBING DATA SETS</b></p>	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
<p><b>2.2 FREQUENCY TABLES &amp; GRAPHS</b></p> <ul style="list-style-type: none"> <li>■ <b>Frequency</b> - number of times a given value occurs in a data set.</li> <li>■ <b>Frequency table (ungrouped)</b> - table with each distinct value along with its corresponding frequency of occurrences.</li> <li>■ <b>Line graph</b> - plot of a frequency table with the values along the horizontal axis and the frequency along the vertical axis. The frequencies of the values are indicated by the height of a vertical line.</li> </ul>	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
<p><b>2.2 FREQUENCY TABLES &amp; GRAPHS</b> Example of a Vertical Line (Projection) Graph</p> 	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>

**Figure 4.** Printable PDF version of the handouts

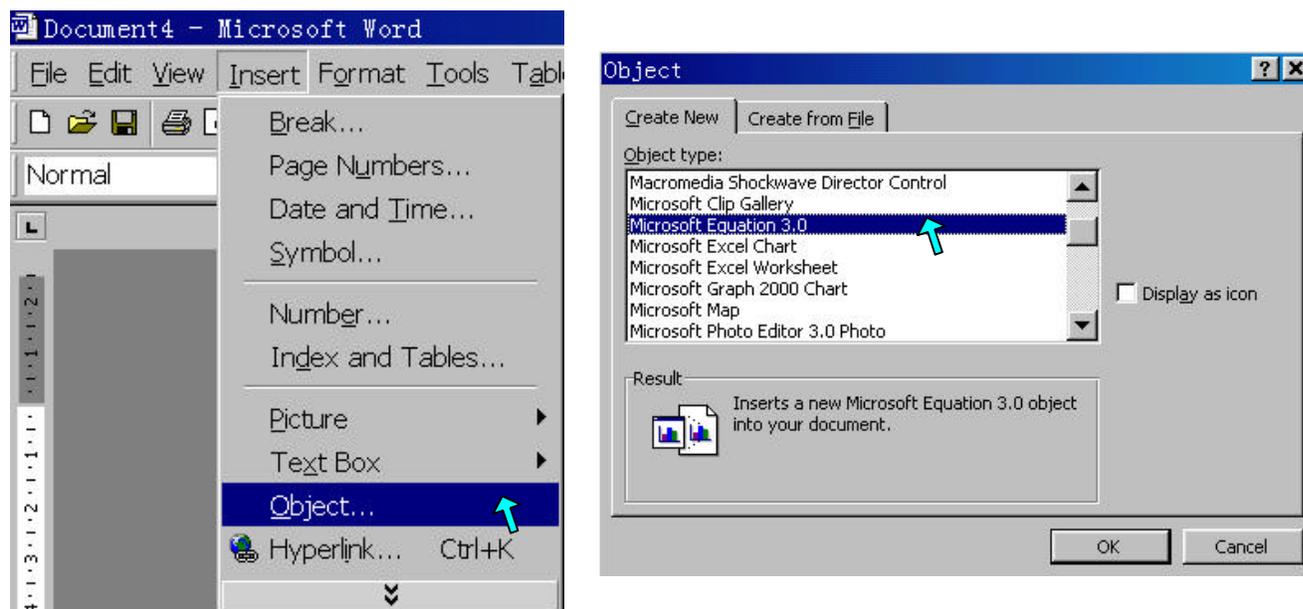
### 3.4 Equation Editor: Math Type

Mathematical equations are an integral part of scientific presentation and effective way of expressing standard mathematical notation and displaying equations on Web pages.

The equations for our slides are created using Equation Editor 3.0 of Microsoft™ which is the junior version of MathType. The reason for our using MS equation editor was due to ease of compatibility and free availability with Power Point and word processors such as MS Word, Corel WordPerfect, and Apple Works.

 **MathType** -- An intelligent equation editor and authoring tool for MathML

The equations for our slides are created using Equation Editor 3.0 of Microsoft™ which is the junior version of MathType. The equation editor is available free within MS Word. For frequent users, Microsoft recommends to upgrade to the MathType™ software by Design Science Inc., which claims to work faster and create better-looking documents. Authors found Equation numbering a useful feature. It has translators that output equations to other languages such as MathML, TeX, LaTeX, AMS-TeX, AMS-Latex, and custom languages. The reason for using MS equation editor was due to ease of compatibility and free availability with Power Point as well as word processors such as MS Word, Corel WordPerfect, AppleWorks. Recent MathType 4.0 use a new translator mechanism that can be customized by the end user to generate MathML for authoring Web pages with mathematics.



**Figure 5. How to Start the MS Equation Editor?**

### 3.5 PowerPoint Animations vs. Flash Animations

To fetch the students' attention, courseware developers sometimes might prefer the use of animation instead of dull, static pages. Due to bandwidth's limitation, it might not be practical to load oversized files to the web page. Among animation software, Flash software has many

distinctions. Flash files exist in a streaming format so that students can follow the real-time tutoring. Thus, it is not necessary to download a whole file to the hard disk of the local machine.

In addition, Flash due to its vector-based graphics system can represent a complex object with a few vectors, which fits well for on-line applications. It also could zoom out without leveling down the frame quality. However, it needs a plug-in installation.

Although simple Power Point animations can also serve the purpose they cannot be copy protected using pdf file format. Pdf format cannot represent well the animations. However, Flash files do not bring such a concern.

### **3.6 Online Text Book for Advanced Material**

In this courseware, in addition to slides Lecture notes are provided. These contain advanced material for those students who are curious and searching for more info to learn and to use. These notes are created using MS word and saved as pdf file (can be saved as html file). The on-line textbook contain multimedia items that cannot be readily presented in an ordinary book, such as audio and video, interactive explorations or explanations of statistical techniques, animated charts and tables that show the real-life investigation results, and spreadsheets.

[ <http://bengu-pc2.njit.edu/bengu/courses/statistics/LectureNotes/Ch2.PDF> ]

### **3.7 Problem Review/Solutions**

A variety of examples that might be encountered in different situations are brought forward in "Review of Problems and Solutions" section. Thinking over these various problems, and then reviewing the corresponding solutions should help to clarify questionable points and reemphasize the important concepts.

[ <http://bengu-pc2.njit.edu/bengu/courses/statistics/Problemssolutions/Sec3-3-1.pdf> ]

### **3.8 Interactive Homework: DISTILS**

Because interactive problems are more challenging, the same variety of model problems and solutions are presented to help students become familiar with appropriate problem-solving methods. Students who have reviewed the Problem Solutions Section now can test their knowledge with this Interactive Quiz System called DISTILS (Distributed Intelligent Learning System).

Three components are involved in our in-house built online quiz system: the question delivery system, the question authoring system and the database. Question delivery system is designed for students to exercise the questions online. The student accounts are individualized with a login id. The numerical questions are randomized to provide fairness among the students as well as to minimize the boredom. The questions are accessed from a SQL database and answers are evaluated with calculated solutions. Question authoring system is designed for professors or users to edit or authorize the questions online. This self-test system allows students to assess their understanding. At the end of each section of a chapter, as an option, a set of numerical

/multiple choice questions are presented allowing students to check if they have focused their attention on important concepts and understood what they have read.

The authoring interface is available for the faculty to readily compose additional quiz questions, both computational and multiple choices, without doing any programming or writing software code. This option provides the adaptability of this system to accommodate individual faculty preferences in terms of how questions are posed and in what order they are expressed.

[<http://bengu-pc2.njit.edu/bengu/courses/statistics/homework/chap33.html> *this site requires id*]

### 3.9 Hands on Training and Online Tutorial Section: SAS and ARENA

In this section, students could get experiences for Advanced Software Application, which gives an edge for job applications and preparations for the business environment. The powerful Statistical analysis tools, SAS and Arena, which are widely used in both Industry and academia, have been included in our courseware as part of teaching material to give hands on exercises for data analysis [<http://bengu-pc2.njit.edu/bengu/courses/statistics/SAS/sasmanual1.htm>],

[<http://bengu-pc2.njit.edu/bengu/courses/Simulation/Arena.htm>].

### 3.10 Digitizing & Streaming Video: Real Publisher/Player

The vivid pictures and sound speeded by video streaming has the great potential to enhance the learning effectiveness of the educational material. It can help two major problems in traditional distance education i.e. improve personal motivation as well as lessen sense of isolation. Real Video/ Publisher software is used in this system to digitize and stream the video applications. The real life applications related to courseware are web streamed to pilot students in their semester projects.



Figure 6. Digitizing & Streaming Video

To further assist students in their projects, project requirements/guidelines are linked to course syllabus; example projects are included to illustrate guidelines. Thus, students can take more control of their learning and can develop "life" skills like time management and research by having to set their own study plans, research additional Web resources, and evaluate their validity and then try to draw sound conclusions.

### 3.11 Group Communication: Web Board, Yahoo Egroups, /Netscape Calendar

Both asynchronous and real-time on-line communication facilities such as e-mail and Webboard can be used very effectively (voice, video, Internet Relay Chat and shared whiteboards over the Net) for enhancing teamwork. These facilities bridge the boundaries and limitations of time and space, and bring a variety of learning styles as well as different navigational preferences. E-mail groups are an excellent opportunities for independent group members to communicate regularly and conveniently. Important due dates, course assignments, group projects as well as discussions may be posted, to keep students aware of course issues that directly affect them. Students must be encouraged to use the e-mail groups to communicate with the instructor or the others in their classes. Staying connected helps students address the requirements of learning. Both WebBoard and Yahoo Egroup (free) are employed in this courseware. Yahoo group is simple to employ and students like it since they can be in charge of their own communication system. In addition Netscape/calender is also powerful tool for scheduling and posting. (<http://yahoogroups.com>)

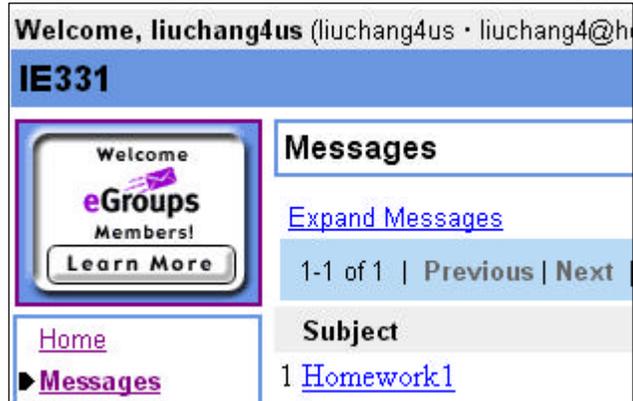


Figure 7. Group Communication-- Egroups

## 4. ASSESMENT OF THE COURSEWARE

Assessments are important part of the courseware, for they provide valuable information for further improvements. The assessment of the content and the courseware itself is completed twice a semester during the midterm and the final exams. Both the power of tech. and the impact of the course in learning are assessed using the student feedback as well as their course grades for each question [<http://bengu-pc2.njit.edu/bengu/courses/statistics/Assesment.PDF>].

The results of evaluations are shared with the students via the web. For objective analysis, student grades are studied for each topic questioned in the test. The topics with high-grade average is assumed to be well understood by most, while the ones with low mean are assumed not. This provided an opportunity to the instructor to revisit the subject matters to make sure that course objectives are achieved. In addition, the variances are also noted; if the variance is very high that means some understood very well while the others not at all; this might be due to students' lack

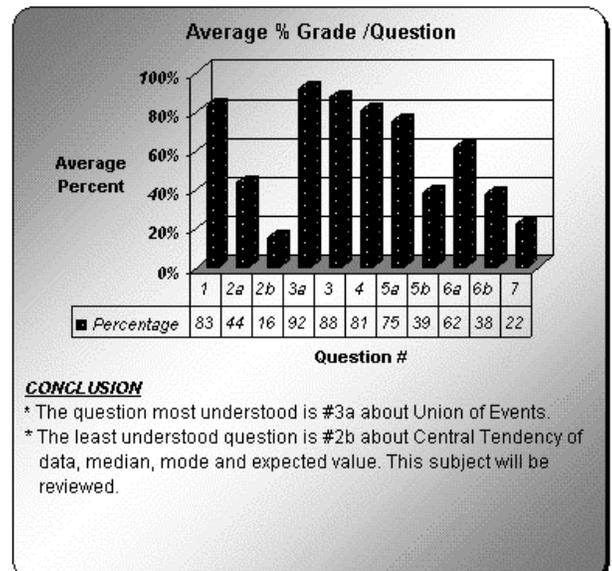


Figure 6. Assessment of the Courseware

of study, or something individual). If variance is low then entire class has the same effect (common cause such as instructor’s sufficient/insufficient explanation, or an interesting /dull topic) which can be attributed. [<http://bengu-pc2.njit.edu/bengu/courses/statistics/ExamAssess/2000MidtermAssessment/ExamPerformance.htm>]

**Table 4. Grade Analysis Using Variance**

Avg. Grade		
High	High	Individual Cause i.e., Student
	Low	Common Cause i.e., Instructor
Low	High	Individual Cause
	Low	Common Cause

The analysis of results documented that the students appreciate the course slides and notes the most among the web based course materials to enrich learning. But when it comes to exam preparation they appreciate most the “Review Problems & Solution” for their preparation. They

clearly state that they like the organization of the course and ease of access. As they get more familiar with the courseware their grades are improved over the exams.

## 5. RESULTS

While students enjoyed the any time anywhere access to the course material, the real life case studies/videos/interactive exercises improved their motivation to learn. The team working provided socialization and on-line and off-line discussion experiences, which prepares them to 21<sup>st</sup> century work environment. The on-line quiz capabilities allow self-assessment for the students; checking that they have mastered the basic concepts and examples. The grade analysis of each subject provided feedback for the instructor and a option to revisit/retest the topics that entire class avg. is low so that the objectives set in the course description are achieved before it is too late to do so. The application of these Web based technology tools in the course instruction and assessment of these tools and the learning/teaching (instructional) methodologies used provides an improved preparation for distance learning (DL) for those interested in using the DL. However, the authors recommend that the best technology plan is a good educational plan [3]. The tools that can let us apply the best instructional methods are sufficient. The authors are working toward wider distribution of these standard courseware design and templates developed both within the institute as well as outside the institution.

## 6. BIBLIOGRAPHY

1. Cao,L., Bengu, G., "Web-based Agents for Reengineering Engineering Education", JECR- Journal of Educational Computing Research, JECR volume 23.4., 2000
2. Bengu, G., et al "Object Oriented Approach in Engineering Education", IEEE-Education, 2000.
3. Kermit, H., “The Best Technology Plan is a Good Educational Plan”. Share the Future – II. A working Conference by NSF- Succeed/Gateway/Foundation, Clemson, S.C., 2001.

## 7. ACKNOWLEDGMENT

Authors would like to thank for the partial support of the dissemination efforts provided by the NSF-Gateway Foundation. This study was originally funded by NJ Commission on Science and Technology through the NJ

Center of Multimedia Research of NJIT and Princeton , and the National Science Foundation under the project called: An Intelligent Learning System: Study Buddy.