Teaching an Introductory Statistics Course with CyberStats, an Electronic Textbook

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Journal of Statistics Education Volume 14, Number 1 (2006), ww2.amstat.org/publications/jse/v14n1/symanzik.html

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Key Words: Computer; Interactivity; Statistical Concepts; Undergraduate Course; Web-enhanced Course.

Abstract

In the Fall 2001 semester, we taught a “Web-enhanced” version of the undergraduate course “Statistical Methods” (STAT 2000) at Utah State University. The course used the electronic textbook CyberStats in addition to “face-to-face” teaching. This paper gives insight in our experiences in teaching this course. We describe the main features of CyberStats, the course content and the teaching techniques used in class, students' reactions and performance, and some specific problems encountered during the course. We compare this Web-enhanced course with other similar textbook-based courses and report instructors' and students' opinions. We finish with a general discussion of advantages and disadvantages of a Web-enhanced statistics course.

1. Introduction

Introductory statistics courses are commonly considered difficult and intrinsically boring by students. Learning statistics requires students to develop a variety of skills. A successful student must gain quantitative and graphical insights along with mathematical and analytical abilities (Härdle, Klinke, and Marron 1999). In addition, it is sometimes difficult for students to relate statistical concepts presented in class to real world problems and everyday situations. Therefore, teaching introductory statistics requires the instructor not only to transmit knowledge, but also to enhance students' motivation and attention.

The idea to incorporate software, in particular teaching software (or “teachware”), at an early stage of the statistical education of students has become very popular during the last few years. An increasing level of computer literacy among students and the availability of necessary equipment in classrooms have stimulated developing and using teachware in introductory statistics courses. Interactivity, hands-on exercises, colorful applets, visualization of statistical concepts, well-documented real-life examples, reduced need for manual calculations, and the possibility of self-assessment and immediate feedback may be the most valuable features of statistical teaching software. They should stimulate the student's activity in class, ease understanding of statistical concepts, and make the whole course more attractive and fun for the student.

Using software when teaching statistics in the classroom varies from occasional interactive exercises and in-class software demonstrations to completely Web-based courses without any use of “traditional” teaching tools or even pen and paper, as in Kent L. Norman's courses cognitron.umd.edu/cognitron.html. An overview of teachware evolution in past years can be found in Symanzik and Vukasinovic (2002).

Currently, there are many statistical teachware packages and electronic textbooks accessible via the Web. Some of them are freely available, such as the Globally Accessible Statistical Procedures (GASP) educational procedures (West, Ogden, and Rossini 1998; West and Ogden 1998a), accessible at www.stat.sc.edu/rsrch/gasp/. Entire (introductory) statistical textbooks have been designed for the Web. Examples of Web-based textbooks that are freely available are David M. Lane's HyperStat (Lane 1999), accessible at davidmlane.com/hyperstat/ and David W. Stockburger's two books Introductory Statistics: Concepts, Models, and Applications (www.psychstat.missouristate.edu/sbk00.htm) and Multivariate Statistics: Concepts, Models, and Applications (www.psychstat.missouristate.edu/MultiBook/mlt00.htm). The UCLA Statistics e-book by Jan de Leeuw, titled Statistics: The Study of Stability in Variation (de Leeuw 1997), formerly freely accessible at www.stat.ucla.edu/textbook/, is currently unavailable since the editor(s) “are unable to maintain it nor complete it at this time due to lack of funds”. Interestingly enough, a page counter, if working properly, indicates that this Web site has been visited more than 70,000 times in about two years since counting started on 10/1/2003. Other electronic textbooks such as Seeing Statistics (www.seeingstatistics.com/) or CyberStats (www.cyberk.com) are commercial packages that allow Web access upon registration. Some of the commercial electronic textbooks are distributed on a CD-ROM in
addition to Web access, e.g., MM*Stat (www.quantlet.com/mdstat/mmstat.html), or on a CD-ROM only, e.g., ActivStats (www.dat.tux.com/products/mediadv/activstats/).

In this paper, we report about our experiences in teaching an introductory statistics course to undergraduate students at Utah State University in the Fall 2001 semester using the electronic textbook CyberStats. We will commonly speak of the Web-enhanced course when referring to this course. Symanzik and Vukasinovic (2002) contains a preliminary version of our teaching experiences with CyberStats, as well as a comparison of CyberStats with other popular teaching software packages. In contrast, Utts, Sommer, Acredolo, Maher, and Matthews (2003) describes a “hybrid” offering of an introductory statistics course that combines a regular textbook with CyberStats. Utts’ class met once a week, but students were required to learn the material on their own using Web-based materials and a textbook.

2. CyberStats

CyberStats is a product of CyberGnostics, Inc. The first version of CyberStats appeared around 1996 and was released to interested individuals free of charge exclusively for test purposes. In Fall 2001, CyberStats Version 2.0 was available as a commercial product. CyberStats is a fully Web-based package and access is granted for about an academic term upon registration and a payment of $33 per individual user. Recently, CyberStats has been purchased by Thomson Learning.

CyberStats possesses all the features of a traditional statistics textbook: coverage of statistical concepts with text, graphics, and exercises. It also includes an interactive table of contents, an interactive index, an interactive glossary, and self-assessment tools. In addition, CyberStats provides all tools necessary for complete course management, such as instructor’s and students’ course Web pages, electronic submission of homework assignments, a message board, and a chat room for students. CyberStats has an automatic timeout feature that terminates a user session if there is no user input for more than 30 minutes (15 minutes when the course was taught).

CyberStats targets students at an introductory statistical level, especially non-science majors. CyberStats emphasises concept understanding, data visualization, and data analysis. Less emphasis is put on formulas and mathematical components of statistics.

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Figure 1. Contents Page of CyberStats.
In CyberStats, the course content is divided into seven sets of units: collecting and visualizing data, modelling random behaviour, inference, regression, design of experiments and ANOVA, time series, and statistical process control. Each set of units consists of one to fourteen units (Figure 1). Units resemble chapters in traditional printed textbooks. Each unit in CyberStats begins with a “Summary”, followed by a set of motivational questions related to the topic (“Think first”). The actual chapter is presented in form of “Three Keys”: “Basics”, where the basic concepts are presented; “Uses”, where a student has a chance to work through a set of examples and exercises; and “Warning”, where potential dangers of wrongly used statistical concepts are discussed. Each of these three keys is accompanied by plenty of examples and exercises and followed by a self-assessment test. In each exercise set, a student can submit the answers to the system, which are automatically recorded on the CyberStats server and can be accessed by the instructor and the student.

To analyze more complex, “real” data sets, advanced electronic textbooks are commonly linked to some full-scale statistical software package. CyberStats was linked to Data Tools, a simplified version of the popular WebStat software (West, et al. 1998; West and Ogden 1998b). Since 2002, the full WebStat 3.0, recently renamed StatCrunch 3.0 (www.statcrunch.com), is tightly integrated into CyberStats.

The core of CyberStats are “Interactives”. “Interactives” are usually invoked in a new window by clicking on one of the many “Interactive” buttons located throughout the CyberStats units. Some of the “Interactive” buttons will start up WebStat and load a data set to analyze. Other “Interactive” buttons will start up “Calculators” or other interactive tools. Here, the user can type in or modify values, use sliders, add points to a graphic by mouse clicks - and immediately see the result of their actions. For students, the CyberStats “Interactives” are considered fun and highly educational at the same time.

A review of CyberStats Version 2.0 can be found in Dear (2001). Comparisons of CyberStats with two other popular teachware packages, ActivStats and MM*Stat, can be found in Symanzik and Vukasinovic (2002) and Symanzik and Vukasinovic (2003). A recent review of six online instructional materials, including CyberStats, can be found in Larreamendy-Joerns, Leinhardt, and Corredor (2005).

3. Teaching STAT 2000 with CyberStats

The introductory statistics course “Statistical Methods” (STAT 2000) is regularly offered at Utah State University (USU). About 40 students register for STAT 2000 each semester. The course objectives are understanding of statistical concepts and inference, development of statistical thinking and problem-solving skills, and equipping students with enough knowledge of statistical techniques to make them capable of doing and understanding basic statistical analyses. Prerequisites are high school algebra and basic computer skills, including the ability to access and use the Web. No prior statistical knowledge is required. The majority of students usually attending this class major in fields such as geography, fisheries and wildlife, animal science, and resources management. Occasionally, students with other majors, ranging from history to computer science, attend STAT 2000. Typically, this course is attended by undergraduate students (commonly from sophomore to senior level), but there are occasionally some graduate students as well. For most of the students, STAT 2000 is the only statistics course they take in their entire curriculum. For some students, STAT 2000 is required as a prerequisite for higher-level specialized courses, such as those on regression methods or experimental design.

In the Fall 2001 semester, USU ran two sections of its introductory statistics course STAT 2000. One section of STAT 2000 in the Fall 2001 semester was a regular textbook-based section, using Moore and McCabe (1999). The other section was a Web-enhanced section using CyberStats only. Students had a choice which section they wanted to attend. The regular section (8:30 - 9:20am) on Monday, Wednesday, and Friday (MWF) had 17 students and the Web-enhanced section (10:30 - 11:20am) on MWF had 14 students. One student who was initially enrolled in the Web-enhanced section changed to the regular section early in the semester, claiming that he usually attending this class major in fields such as geography, fisheries and wildlife, animal science, and resources management. The fact that the Web-enhanced section took place only one hour after the regular section three days a week is a potentially very important confounding factor for the results, given that the same instructor taught both sections. Ideally, even if an instructor tries to present the course material as similarly as possible in consecutive sections of the same course, we have to assume that the material presented is most likely not the same. Sometimes the second class may benefit due to insights gained from the first lecture, but sometimes the second class may also be disadvantaged because the instructor may skip something already taught that day to the first class. But, because Moore and McCabe (1999) and CyberStats use quite different methods to introduce “similar” topics and the order of these topics is different, one should really treat these two sections as unrelated. Nevertheless, we frequently refer to the regular textbook-based section to highlight similarities, differences, and possible confounding factors.

The reason why we had to run two sections of STAT 2000 in the Fall 2001 semester (instead of just a Web-enhanced section) whereas only one section of STAT 2000 had been offered in previous semesters was due to capacity limitations of our electronic classrooms - the largest available computer classroom at USU could not hold the 40 students expected to attend STAT 2000. Even the 31 students that actually attended these two sections surpassed the maximum cap size of 25 students for the electronic classroom that was used.
Although the results described below are only the outcome of an observational study and not of a controlled experiment (because students could decide themselves which section to attend), we have made some interesting observations. These may be of interest not only for instructors using CyberStats but also for instructors interested in working with other electronic textbooks.

Student attendance was similarly high in both sections in the Fall 2001 semester (although no exact counts were taken) and the dropout rate (0%) was exceptionally low in both sections, compared to previous offerings of this course. Because this was observed in both sections, it cannot be attributed to any of the two course formats. More likely, the overall small class size and closer interaction between instructor and students in both sections may have been a major confounding factor here.

No major difference in the grade distribution for the Web-enhanced section and previous grade distributions by the same instructor can be noticed for the A, B, C, and D grades. The relatively high percentage of A grades (five out of fourteen students, i.e., 36%) in the Web-enhanced section can be easily explained by chance, recalling that there were only fourteen students in that section. However, the lack of any F grades in both Fall 2001 sections is noticeable. Confounding factors such as smaller class size (previous offerings had between 32 and 48 students in a section), closer interaction between instructor and students, and overall higher attendance may lead to this outcome in both Fall 2001 sections.

Due to the different arrangement of lecture topics in Moore and McCabe (1999) and CyberStats, it was not possible to provide identical exams for the two sections. However, about 50% of the questions in all exams were identical for both sections. There was no noticeable difference in the students' exam performance between the two sections.

Homework assignments in both sections accounted for 300 points out of a total of 1000 points, i.e., 30% of the course grade. Thirteen homework assignments (at 25 points each) consisting of multiple questions were assigned throughout the semester. Each question in each homework assignment was graded on a done/not done basis (rather than a correct/incorrect basis), thus resulting in zero points or full points for this question. The sum of these points was the weekly homework score. Only the highest twelve of the thirteen weekly homework scores were used for the total homework score. The idea of awarding points for working on and turning in answers to homework assignments (rather than awarding points for correct answers only) was previously found to be an effective means of motivating students to work more independently on the assignments and turn in their own answers rather than working on assignments as a group or simply copying answers. Because homework assignments were not graded in detail, solutions by the instructor were provided for each assignment.

The homework assignments for the Web-enhanced section consisted of CyberStats and non-CyberStats questions. Non-CyberStats questions included old exam questions (from previous regular course offerings) and questions from other sources. The homework assignments for the regular section included the same non-CyberStats questions, whereas the CyberStats portion of the assignment was replaced with questions from the Moore and McCabe (1999) textbook. A closer look at the homework scores reveals some interesting results: Except for one outlier (196 points), all homework scores in the regular section ranged from 263 to 300 points, with a median of 299 points. Similarly, the Web-enhanced section had two outliers (38 and 184 points). The student with the 38 points missed many classes and only submitted answers to two homework assignments, but nevertheless performed well enough in the exams to obtain a “D” grade overall. The remaining homework scores in the Web-enhanced section ranged from 259 to 300 points, with a median of 290 points. Some small differences could be observed between the two sections when looking at student grades. While all “A” and “B” students from the regular section had almost perfect homework scores (298 through 300 points), this was the case only for the “A” students from the Web-enhanced section. The “B” and “C” students from this section lost most of their homework points on non-CyberStats questions. It should be noted that CyberStats homework questions had to be submitted electronically while working with CyberStats while the non-CyberStats questions had to be e-mailed, faxed, or turned in during class. One possible explanation for a slightly lower submission rate of non-CyberStats questions might be that it was more convenient to answer questions electronically and less convenient to turn in additional written answers. Another possible explanation might be that the non-CyberStats questions were not related too well to the Web-enhanced course content, but better matched the regular course content.

### 3.1 CyberStats Course Material

Prior to teaching the Web-enhanced section of STAT 2000, it was planned to cover material that is also covered in the regular section. This would have been units A-1 through A-8, B-1 through B-9, B-11, B-12, C-1 through C-4, C-6, and D-1 through D-3 in CyberStats (as shown in Figure 1). Additional material to be discussed in both sections should have covered the use and misuse of statistical graphics, scatterplots, and the idea of linked and geographic scatterplot brushing, micromaps, and mosaic plots.

However, it was not possible to discuss all material that was initially planned in the Web-enhanced section. Units B-11, C-1 through C-4, C-6, and mosaic plots were omitted in the Web-enhanced section, whereas all planned material was discussed in the textbook-based section. There are several reasons for these omissions from the Web-enhanced section:

- Interactive teaching using the Web in class requires considerably more time than teaching the same material on the board. The instructor has to make sure that each student arrives at the intended Web page that contains the interactive applet that is being used in class. At the beginning of a class, it often took 5 to 7 minutes before each student arrived at a designated Web page (going to CyberStats first, logging on, navigating from the main menu to a unit, and finding and starting the “Interactive” in a unit).

- Technical problems, related to the USU computer system (and not to CyberStats) required some spontaneous reorganization of lectures. During four lectures, the instructor's computer was not able to access the Web, during another four lectures, students did not have Web access (instructor's computer and student computers were differently routed). This considerably affected the flow.
of those eight lectures. Also, having to work on the board and demonstrating the most useful “Interactives” in a later lecture instead of the one where an “Interactive” would be most beneficial took additional time and reduced the effect of some “Interactives”.

- Incompatibilities between different settings with respect to Web browsers and Data Tools/WebStat caused major delays in class. Due to a restricted availability of the electronic classroom at USU, it was not possible to test all features of CyberStats in the classroom prior to a lecture. Instead, the instructor's personal laptop and the SGI workstation in his office had been used for testing. Usually, everything worked as expected for the instructor. Unfortunately, long delays occurred in the classroom because features for incorporating data (copy/paste, load from URL, etc.) worked differently (or did not work at all) under Netscape and Internet Explorer for Data Tools and WebStat. After a complete failure in one lecture to load data, it took half of the next lecture before every student was using the correct Web browser and the correct approach to incorporate the data.

- Additional depth of some of the material in CyberStats compared to the regular textbook resulted in more time spent on some of the topics in the Web-enhanced section than previously planned.

Overall, working with CyberStats requires a careful reevaluation of what can be taught in one semester. Although it is unlikely that other instructors will encounter the same technological problems, one should expect unavoidable delays to occur over the course of a semester when using technology in class. This includes problems with computers, Web access, and related technology such as projection devices. In case of such problems, it might be helpful to have some additional course material at hand to cover part of, or, in the worst case, an entire lecture. This can be review material (on topics such as probability, regression, or normal distribution) that otherwise would be discussed before an upcoming exam or optional course material that can be discussed without the classroom technology (such as examples of statistical graphics that go beyond the electronic textbook and can be introduced via handouts).

3.2 Teaching Style with CyberStats

Regarding the teaching style, several alternatives have been tried. In the beginning of the semester, when topics such as data collection, sampling, experiments and observational studies had been discussed, the course format was mostly discussion-based (with no extra handouts), using examples and the self-assessment questions from CyberStats as a basis. Later in the semester, when talking about linear regression, a more hands-on approach was used, with some comments and sketches on the board and more work with the “Interactives” and Data Tools/WebStat. There was little focus on hand-calculations and formulas, although formulas have been briefly explained. Eventually, topics such as variance/standard deviation, binomial random variables, and the normal distribution have been discussed by combining handouts adopted from the regular section with the “Interactives” within CyberStats.

The main task for an instructor when using CyberStats in a classroom setting is to integrate the given technology, in particular the “Interactives” and Data Tools/WebStat, into the overall course material. CyberStats states on the instructor screen: “We strongly recommend that you [do] not start a CyberStats course before investing a few hours in organizing it.” Finding an optimal teaching style that incorporates technology probably requires more effort than designing a good regular course.

Clearly, to teach a course in this “Web-enhanced face-to-face” format, an instructor should be generally familiar with current Web technology and features. While a regular textbook is often straightforward to transfer into a lecture, a Web-based textbook such as CyberStats provides far more material and options than what can be discussed in class and therefore requires a more rigorous selection by the instructor. This includes a large number of readily available data sets and “Interactives” in CyberStats that require a detailed screening. Also, an instructor should be somewhat prepared to solve at least minor technical problems that may occur during the classroom sessions.

Finally, it should be stated that the instructor should not expect that many students work on “Interactives” prior to a lecture unless credit is given. When asking students to work on a particular “Interactive” for the next lecture (without providing credit for doing so) with the intention of discussing the students' observations and results during that lecture, there was rarely any student who did the work prior to class. Eventually, towards the end of the semester, all “Interactives” worth discussing have been discussed in class or have been assigned as a homework assignment with credit. Possibly, assigning most “Interactives” from the beginning on as homework assignments with credit might have freed enough class time to cover content similar to a regular course. The reader should be reminded that most of the attending students were undergraduates. Graduate students might be more mature and willing to do some extra work even without getting immediate credit for it.

3.3 Course Evaluation and CyberStats Extra Questionnaire

Sixteen students (out of seventeen) from the regular section and twelve students (out of fourteen) from the Web-enhanced section filled out the official teacher/course evaluation form during the last week of the semester. Based on a scale ranging from 6 (excellent) down to 1 (very poor), the “Overall quality of the course” obtained a mean of 4.3 (with a standard deviation of 0.86) in the regular section and a mean of 4.2 (0.83) in the Web-enhanced section. The “Instructor's effectiveness” obtained a mean of 4.1 (0.81) in the regular section and a mean of 4.2 (1.03) in the Web-enhanced section, i.e., there was no significant difference in these two criteria between the two sections. When compared with the results from previous offerings of this course, the Fall 2001 results were identical to the median and also to the mean outcomes over the previous years. Also, none of the other 18 criteria on the official evaluation showed major differences between the two sections. The highest difference was observed for “Course organization” with a 4.6 (1.26) for the regular section and 4.0 (1.04) for the Web-enhanced section. This difference may be attributed to the fact that it was not always possible to teach the intended material due to the reported problems to access CyberStats and the required reorganization of course material, which
resulted in jumps from one topic to another.

In addition, students could comment on aspects of the teaching or content of this course that were especially good and suggest changes to improve the teaching or the content. In the Web-enhanced section, four students listed CyberStats (and the “Interactives”) and its combined use with handouts in a lecture format as “especially good”. In the “changes” question, six students of the Web-enhanced section had no suggestion at all. None of the suggested changes was listed more than once and only one student suggested not to use CyberStats.

In addition to the official teacher/course evaluation, an additional CyberStats questionnaire with extra questions related to CyberStats had been handed out in the Web-enhanced section. This questionnaire was designed by the authors of this paper with the intention to learn more about students’ opinions and suggestions regarding CyberStats. It was not intended to duplicate questions from the official teacher/course evaluation discussed above that was handed out in both sections. Thirteen (out of fourteen) students answered the additional CyberStats questionnaire. It should be noted that some students listed more than one feature. The questions and most frequently given answers follow below:

1. **What did you like most in CyberStats?**
   Eleven students cited the “Interactives”, three students liked the possibility to submit homework answers electronically, and two students liked the examples best, in particular the ones related to popular issues such as AIDS and social problems. Five students listed different advantages of electronic books such as the self-assessment with answers to the problems, the glossary and the ease of finding definitions, and the overall user-friendliness.

2. **What did you like least in CyberStats?**
   Four students complained that CyberStats or the access to it often did not work. Two students stated that they had no computer access at home and therefore could not work on homework assignments at home. Two students did not like the time it takes to access CyberStats and find information and that it is impossible to mark information. Several other topics have been listed once, including the price. Only one student did not like CyberStats at all.

3. **Are there any particular problems you would like to see fixed in CyberStats?**
   Four students would like to see a fix of the timeout issue, such that they are no longer being kicked out of CyberStats after 15 minutes without reloading a new page. Three students would like to see fixes related to the speed of the server, internet access, or that they simply do not have to depend on the Web anymore. Several other topics have been listed once. Three students did not have any suggestions.

4. **Overall, did you enjoy working with CyberStats? Circle one of the answers:**
   - Yes, a lot. [5 students]
   - A little bit. [7 students]
   - Not very much. [0 students]
   - No, not at all. [1 student]

5. **What did you like most in the way this course was taught?**
   Five students liked the open book exams most, which allowed them to use CyberStats during the exam and to look up definitions and examples within CyberStats. Four students mentioned the combination of CyberStats and additional handouts. Four students liked the fact that this course was taught by a good instructor (and not only through the Web without instructor) and using technology as a tool. A few other topics have been listed once. Only one student did not have any suggestion.

6. **What did you like least in the way this course was taught?**
   Three students liked least when CyberStats or the access to it did not work and that it was hard to do homework assignments with no computer access at home. Two students thought that there was too much emphasis on computers and did not like that almost everything was online. Otherwise, one student did not like the combination of CyberStats and additional handouts and would have preferred either CyberStats or handouts only. Three students had specific comments regarding exams. Three students did not suggest any topic they liked least.

7. **Do you have any suggestions how to improve the teaching of this course when using CyberStats?**
   While some suggestions have been given once, nine students did not suggest any improvements or just indicated that some of the problems with CyberStats encountered early in the semester have been worked out towards the end of the semester.

8. **Overall, what would you suggest for future Stat 2000 classes here at USU? Ultimately, we can either use CyberStats or a standard textbook, but we have to decide for one of these two options. Circle one of the answers:**
   - Use CyberStats for all future Stat 2000 classes. [6 students]
   - Fix the problems mentioned before, then do another experimental class with CyberStats and only decide then whether to use CyberStats or a textbook. [6 students]
   - Do not use CyberStats and immediately decide to work with a standard textbook for all future Stat 2000 classes. [1 student]

3.4 **Instructors’ Comments on Evaluation and Questionnaire**

Even though there was no major difference in the overall course evaluation of the Web-enhanced and the regular sections (in Fall 2001
and previous years), it appears that the majority of students who took the Web-enhanced section overall enjoyed it, in particular the “Interactives”, the possibility to submit homework answers electronically, and the access to CyberStats during the exams. However, as previously stated, the comparison between the two sections was not a designed experiment because students could decide themselves which section to attend.

Problems that were mentioned all over again relate to the nature of a Web-based textbook: problems to access it at all, slow access, problems to work on homework assignments if no computer is available at home, difficulties to find something in the electronic version, and no possibility to mark and highlight important facts in an electronic book. One of the cited problems was immediately fixed during the semester: students are no longer automatically logged out of CyberStats after 15 minutes of idle time. Because CyberStats is undergoing continuous revisions and updates, one can assume that most of the other listed inconveniences have disappeared by now. Furthermore, the general accessibility of the Web has become much easier for students and instructors now. Based on the experience with the Web-enhanced section and the students' suggestions, one should definitely consider CyberStats (or any other electronic textbook) for future use in Utah State's STAT 2000 class.

Even though the additional questionnaire suggests that CyberStats was popular among the students, it can be noticed that the overall performance of students and the overall course/instructor evaluation was within the range of previous courses. Only subjectively, students had the impression that CyberStats is better than a regular textbook. Nevertheless, as stated in the Introduction, electronic textbooks are important to better motivate students and teach statistical ideas and concepts in a more convenient manner.

4. Discussion and Future Research

Statistics textbooks such as CyberStats that are available in non-standard form, in particular on the Web (or on CD), have considerable advantages but also disadvantages compared to a regular, printed textbook. For a Web-only textbook, the main disadvantages are access-related problems such as slow connections and servers that are down. Also, students that live further away from the university and do not have a computer at home have a clear disadvantage as they have to commute to the university to access the system and read the course material and work on homework problems.

Not having a printed version of a textbook (as was the case for CyberStats when this course was taught) is inconvenient for the instructor as well. It is very difficult to determine on the computer screen which exercises to assign, in particular when there is more than just one set of exercises for a unit or when a homework assignment consists of questions related to several units. Eventually, all available exercises (and solutions) were printed out to obtain a better overview of available questions before assigning selected exercises. Also, looking up a definition or an example in a Web-only textbook is time consuming, in particular when this is done from home and a network connection has to be established, the Web page has to be accessed, and the required information needs to be searched. Finding a definition or an example in a printed textbook is much faster. So, many students ended up printing the entire course material from the Web. Recently, the CyberStats developers have addressed some of these problems. Instructors and students can now purchase a “print companion” to CyberStats containing a selection of units discussed in their course. Also, further progress in technology will resolve some of these limitations.

Clearly, a Web-based textbook has an immediate advantage: errors and typos can be fixed immediately. It does not take several months (or years) before the next updated edition of a textbook on CD or in print is being published. Certainly, in the case of CyberStats, this is attributed to its very efficient and helpful technical support, who almost instantly fixed every problem reported by the instructors.

However, as experiences with MM*Stat show Rönz, Müller, and Ziegenhagen (2000), about 48% of the students prefer the CD-ROM version, 40% prefer the Web version, and 12% have no preference. The CD has the advantage that it is independent from a network connection and can be run on virtually any computer. Servers that are down, slow connections, a telephone line for a modem that is shared by three or four roommates - these are features the CD does not depend on. Unfortunately, CyberStats cannot be offered on CD-ROM due to its current implementation.

Another main advantage of a Web-based textbook, compared to a CD or a printed version, is the possibility for students to upload homework answers to the main server and for instructors to download these answers after the submission deadline. After some initial technical difficulties with timeout problems and the access to the server, the homework upload was well accepted among the CyberStats students. As described before, the “B” and “C” students from the Web-enhanced section turned in the CyberStats questions but often did not turn in the additional homework exercises on paper. CyberStats offers a possibility to give students an entirely electronic exam: the “Test Bank” allows instructors to write electronic exams that include the instructor's own questions, CyberStats questions, and questions from other instructors who use CyberStats. However, this feature was not used during this offering of the Web-enhanced course.

To summarize, the main advantage of electronic textbooks on the Web (or on CD), such as CyberStats, clearly is the interactivity (as provided by the CyberStats “Interactives”) that allows students to actively learn statistics. Also, the ability to work on homework problems on the computer and upload answers to a server from which they can be downloaded by the instructor after the due date is a major advantage for students and the instructor.

Ideally, an electronic textbook (Web-based or on CD) should not be used alone, but accompanied by a printed book and optionally with the other electronic format. An additional printed textbook such as the CyberStats “print companion” has several benefits. In particular, it is faster to “access” a textbook and find the desired information. The textbook can be read while commuting in buses or trains, it can
be taken back home over the weekend, and it can be read during short breaks at the university when no computer lab is at hand. Otherwise, a Web-based electronic textbook has the advantage to include corrections quickly and the convenience to answer homework questions electronically and upload them to a server.

Based on this summary, the current version of CyberStats is already very close to an “ideal” electronic textbook. Additional features are added regularly by the CyberStats developers and its publisher. However, instructors still have to consider carefully whether CyberStats is appropriate for use in a particular course. Its developers suggest that CyberStats can be used (i) instead of a regular textbook, (ii) in addition to a regular textbook, and (iii) for distance education.

Clearly, CyberStats is ideally suited for distance education, i.e., option (iii). When a regular textbook (that usually costs between $50 and $100) is being used, it seems to be doubtful whether students are willing to pay an additional amount of $33 for the CyberStats access - so option (ii) may not be selected frequently.

When CyberStats is used instead of a regular textbook, i.e., option (i), we would highly recommend its use in an electronic classroom setting, in particular for undergraduate students. Based on our experience, it is doubtful whether undergraduate students are motivated enough to work through the electronic course material just by themselves. When teaching a class based on CyberStats in an electronic classroom, the instructor can assure that the most relevant CyberStats Web pages, exercises, and “Interactives” are visited and further explained during class time. The instructor may assign additional exercises and “Interactives” as homework.

In conclusion, it seems that using CyberStats in a classroom could be considered a useful way of combining advantages of technology with in-class instruction. Both the instructors and the students have experienced a somewhat different kind of a statistics course. Based on the positive, encouraging feedback from the Web-enhanced section, we would like to continue experimenting with CyberStats in our introductory STAT 2000 course. Unfortunately, high enrolment numbers in STAT 2000, beyond the capacity of our largest electronic classroom, have prevented us from further experimenting with CyberStats at Utah State University in recent semesters in this “Web-enhanced face-to-face” format although CyberStats is currently being used for the distance education versions of STAT 2000 and STAT 2300. We hope, however, that additional resources will become available in the future - either in form of expansion of the existing computer classrooms or engaging new personnel to teach an additional course section, which would make it possible to permanently transform the campus version of STAT 2000 into the “Web-enhanced face-to-face” format.

We want to finish our discussion with a list of open questions that deserve further investigation:

- When we taught these two sections of STAT 2000, students could decide themselves whether to take the regular or the Web-enhanced course. However, it should be investigated how students who would not decide themselves to take the Web-enhanced course react to an electronic textbook before permanently adopting CyberStats (or any other) electronic textbook.

- As noted, the “B” and “C” students in the Web-enhanced section were less likely to turn in homework answers on paper than to submit homework answers electronically through CyberStats. It would be interesting to conduct an experiment, determining whether there is indeed a significant difference in homework-answering behavior when all questions can be turned in electronically rather than on paper (and also whether electronic answers will show more similarities among students than written answers, i.e., that more collaboration and copying is going to take place among students).

- The most difficult question to answer remains: Do students better understand statistics with a Web-enhanced course, with a regular course, or is there no significant difference in students’ performance when comparing these different course formats? This question will only be answered if it is possible to run additional sections of the Web-enhanced and the regular course in a comparative way and obtain reliable data for a large number of students from both course formats.

Acknowledgments

The authors want to thank Dan Coster for providing information on previous STAT 2000 courses, Palyne Gaenir for technical assistance with CyberStats, and Alexander Kugushev for helpful comments regarding CyberStats. We would also like to thank the Editor, Associate Editor, and the anonymous reviewers of the Journal of Statistics Education for their constructive criticism and suggestions how to improve this paper. All URLs mentioned in this paper have been verified on March 24, 2006. Some parts of this publication were previously published as Symanzik and Yukasimovic (2002) which is copyrighted by Physica-Verlag, Heidelberg.

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