IMPLEMENTING SAS AND ENTERPRISE GUIDE TO ENHANCE A GRADUATE BIOSTATISTICS CURRICULUM

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ABSTRACT

In 2005 Thomas Jefferson University implemented SAS/Enterprise Guide (EG) to upgrade the biostatistics curricula of its Public Health and Pharmacology Master's degree programs. Prior to 2005, all biostatistics instruction had employed only manual methods. The Biostatistics Working Group (BWG) was convened early in 2004, comprised of all faculty teaching graduate biostatistics courses. The BWG evaluated 3 statistical packages and selected SAS/EG, and evaluated facilities on campus and selected the Library's electronic classroom. The two presenters expanded the site license from 50 workstations to 100, collaborated with Jefferson Academic Information Services and Research (ASIR) staff to revise the image and deploy SAS/EG on all 30 workstations in the library's electronic classroom, and collaborated with SAS and ASIR staff to develop a student home use agreement. Thus far, 3 instructors, assisted by 1 Teaching Assistant (TA), have taught 7 courses, including more than 125 students. Students have learned how to use EG to perform data management and statistical analyses such as t-tests and chi-square tests. Some faculty and students have used EG in other courses; and several students have used EG to perform the data analyses in their Master's theses. The key technical challenges have been providing effective remote support to students whose home PCs employ a variety of hardware platforms and operating systems, and maintaining the integrity of the electronic classroom and home installations.

THE PROBLEM: NEED FOR STATISTICAL SOFTWARE EXPERIENCE

The Thomas Jefferson University College of Graduate Studies (JCGS) has numerous Doctoral and Masters degree programs. Specifically, the Master's degree programs in Pharmacology and Public Health require successful completion of the Introduction to Biostatistics graduate course (GC660); a second course in regression analysis (GC670) is available but is not required by any program. In early 2004, both courses still provided only manual calculation experience rather than experience with statistical software.

In light of the clear need to upgrade students' training and experience, a group of JCGS faculty and staff were charged with the responsibility of upgrading the biostatistics curricula of the JCGS programs by selecting and implementing a statistical package to provide students with hands-experience. The composition of this group, the Biostatistics Working Group (BWG), was:

- Howard Chapman, BA, Research Analyst, Department of Health Policy, and Teaching Assistant, Jefferson College of Graduate Studies.

- Albert G. Crawford, PhD, MBA, MSIS, SAS Certified Professional Level I, Assistant Professor of Health Policy,
- James Diamond, PhD, Director of Research, Department of Family and Community Medicine,
- Christine Hartmann, Assistant Professor of Health Policy,
- Jennifer Lofland, PharmD, MPH, PhD, Research Assistant Professor of Medicine,
- Jennifer Ravelli, Program Coordinator of the M.S. in Public Health Program, and
- Kathryn Winter, MS, Instructor, Jefferson College of Graduate Studies,

The BWG met numerous times throughout 2004 and confronted a series of key decisions:
- Which statistical software package to use?
- Whether to use the graphical user interface (GUI) version, if available?
- Whether to allow/require student home use?
- What facility on campus to use to allow hands-on instruction and learning?
- What textbook(s) to use?

THE SOLUTION: STATISTICAL SOFTWARE EXPERIENCE

This section discusses the issues confronted, deliberations, decisions, and rationales for key decisions regarding the identification, selection, and implementation of statistical software in JCGS biostatistics courses.

Criteria for Evaluating Biostatistical Software for Classroom Instruction

The BWG developed the following criteria by which to identify and evaluate statistical packages:
- Functionality, i.e., statistical procedures included and their reliability
- Usability, including whether a Graphical User Interface (GUI) version was available
- Existing level of use on campus, i.e., number of users, presence/availability of site-license
- Degree to which the software was an industry "standard" in biomedical research, including the pharmaceutical and healthcare industries, and including randomized clinical trials, epidemiology, pharmacoeconomics, outcomes research, and health services research
- Cost, including both the software cost and any related implementation costs, including instructor training costs, costs of making copies for home use as well as classroom use, etc.

The Potential Solutions: Software Packages Evaluated

The BWG identified 3 candidate software packages, based on the criteria delineated above:
- SAS/Enterprise Guide
- SPSS
- Stata

The Solution Selected: SAS/Enterprise Guide

The BWG selected SAS/EG because it was:

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- judged to be as full-featured and reliable as any other package
- the most widely used package in industry, maximizing students' clerkship, thesis, and employment opportunities
- the most widely used package on campus in general, and specifically by the members of the BWG, who would be teaching the course (this reduced instructor training costs to $0),
- highly price-competitive, especially given:
- our ability to scale up the existing 50-seat site license to 100 seats, and
- the absence of any additional costs for student home use

Allowing/Requiring Student Home Use and Developing a Student Home Use Agreement

As the BWG evaluated our options, we realized that, since several of the software packages allow home use, we could allow it, if not require it. The next task was to craft an appropriate Home use agreement. One BWG member (Crawford) worked with both SAS Institute, Inc. staff and the Director of Jefferson Academic Information Services and Research (ASIR), Edward Tawyea, to develop a student home use agreement. The language we adopted was as follows: "Thomas Jefferson University is providing you with a copy of SAS / Enterprise Guide (EG) as part of the GC660 course in which you are enrolled. There are certain limitations to which you must agree in order to receive the SAS/EG CDs for installation and home use. By signing this agreement, you are agreeing to abide by the terms set forth below.
By signing this agreement:
- You acknowledge that the software you will be receiving is copyrighted, proprietary work belonging to the SAS Institute.
- You agree not to copy or allow anyone else to use this software.
- You agree not to use the software for (a) commercial or profit making purposes;
  (b) remote computing services, time-sharing, facilities management, or any other third party access arrangement; or
  (c) processing third party data.
- If you are required to return the CDs at any point before the course is over, you will do so."

There were no problems in implementing this agreement. All students chose to sign the agreement, no students complained about its terms, and all students have abided by those terms.

Electronic Classroom Evaluation and Selection

Criteria which the BWG considered in evaluating the limited candidate electronic classroom facilities on campus included:
- PC hardware requirements/capabilities, i.e., processor speed, memory, graphics capability, storage, network backup/restore capability
- Operating system, i.e., Windows version
- Classroom physical layout, number of seats/workstations, etc.
- Presentation capability, i.e., data projector driven by instructor's PC

The BWG had only 2 facilities on campus to consider which could serve as the required electronic classroom. Of these 2, one was clearly superior: the electronic classroom in the Scott Memorial Library, which had 30 workstations, 5 rows with 6 workstations per row (although,

unfortunately, the front row of 6 workstations was too far forward to be usable), a screen, and a data projector which could be driven by either of 2 workstations in the 2nd row. The maximum feasible enrollment, 23 students, effectively reduced class sizes by more than 50% (from 50 previously). Thus, class size reduction has been a serendipitous, but beneficial, result of the SAS/EG implementation.

Textbook Evaluation and Selection

There was wide variation in the availability of textbooks for the 3 statistical packages considered.
- SAS/EG: While there were numerous textbooks available to accompany conventional SAS, there were none available for EG during the BWG's evaluation phase. James Davis was working on his statistics text customized for use of EG during the BWG's evaluation phase, and SAS Institute, Inc. offered to make copies of selected chapters available for free in exchange for instructor feedback about its usability.
- SPSS: Numerous texts were available.
- Stata: Few texts were available.

A separate decision made by the BWG obviated the need to select a text. The BWG decided to phase in the hands-on approach by offering 2 sections of a new, temporary, 1-credit course, GC661, focused on hands-on experience, for those students who had already taken the conventional 2-credit version of GC660. In these 2 relatively small sections, the instructors (first Winter and then Crawford) and TA (Chapman) found that it was unnecessary to use a text which integrates conventional instruction in statistics with software training. Teaching students to use EG proved very simple and easy, compared with teaching them biostatistics.

The standard text employed was Daniel WW. Biostatistics: a Foundation for Analysis in the Health Sciences. 8th ed. John Wiley & Sons, Inc.: Hoboken, NJ: 2005. ISBN: 0-471-45654-3. Various editions of Daniel's text have served as the JCGS standard for the last 20-25 years.

THE IMPLEMENTATION: INFORMATION TECHNOLOGY ISSUES

Developing and Maintaining an Image for the PCs in the Electronic Classroom

We worked with ASIR staff to develop, deploy, update, and maintain the SAS/EG component of the image used on all 30 PCs in the electronic classroom, including the annually-required SETINIT files. There were relatively few problems with this process.

On the other hand, one feature of the maintenance of the PCs in the electronic classroom has been problematic. Periodically, either nightly or weekly, ASIR deletes all files on the PC hard drives other than the image. The consequence is that GC660 students cannot rely on saving their work to the PCs' hard drives. The solution the instructors have chosen is for students to use their own media, i.e., flash drives. While using flash drives is not required, it is strongly recommended.

Developing CDs for Student Home PC Installation

CD development involved creating an image CD using the "Create a Development CD" function provided with the SAS Administrator CD case. The CDs were created with several components of the core SAS application on CD #1 and SAS Enterprise Guide on CD #2. The core SAS components include Base SAS, SAS Graph, SAS Q/C, and PC File Formats (providing capability to handle PC files). After all components were selected, the image was created and stored on our server, and a master CD was created. Using CD burning software, we duplicated a sufficient quantity of CDs and distributed them upon receipt of a signed "Home User License Agreement". The creation of the development CD is repeated once a year as our site license is renewed and a new setinit file is issued, containing our site license start and expiration date information.

Installation Guide

The installation guide serves as the user's manual for installing the software. The installation guide is a 15-17 page document with instructions and color screenshots of every step in the installation process. The guide walks students through the installation of conventional SAS and Enterprise Guide. The installation guide Word file is copied onto the CDs given to the students for home use and posted to Blackboard^{TM} (see below) for students to download.

Providing Remote Support

Providing remote support has been one of the biggest challenges we have faced. Specifically, we must address a wide variety of hardware platforms and versions and releases of the Windows operating system (OS). Since EG does not run on Macintosh OSs, we cannot support Macintosh computers, and we inform students of this gap at the outset of each course. Since EG only runs on 2 versions of Windows, XP and 2000, we inform students of this issue at the outset of each course, and we work with them to upgrade to a supported version, if feasible, e.g., coaching them as they install required service packs.

Students who encounter serious problems installing SAS/EG on their laptops are encouraged to bring them in for hands-on support. On the other hand, providing remote support to students encountering serious problems installing SAS/EG on their desktops has proven to be much more complicated. To address these issues, the TA (Chapman):
- developed a detailed installation guide, and customized it as needed for the 2 Windows versions supported by SAS/EG,
- guided students through the process of upgrading their Windows installations, e.g., installing required service packs,
- guided students through various installation issues, and
- used Blackboard's Discussion Board (see below) as a medium to address individual student issues in a way that informs other students who might experience the same issue.

We estimate that, ultimately, 35-40% of students succeeded at installing SAS/EG on their home machines. While we have been disappointed by this result, we anticipate that the home PC installation rate will increase as course requirements increasingly include use of statistical

software. Given the high degree of availability of SAS/EG in the electronic classroom in the Library (currently, 79 hours per week), the low home PC installation rate, while disappointing to the BWG, did not pose serious pedagogical problems.

THE IMPLEMENTATION: INSTRUCTIONAL ISSUES

Instructor Training

Given the choice of SAS, in which all instructors in the BWG were already proficient, the only training issue was training to upgrade or transfer instructors' skills to include EG. The 3 instructors (Winter, Crawford, and Diamond) easily taught themselves how to use EG. And, as usual, SAS Institute, Inc. technical support staff provided excellent support. Additionally, Mr. Chapman, originally a student in the 1st offering of GC661, learned EG rapidly enough that he served as the TA in the remaining section of GC661 and served as the TA in all 5 sections of the 3-credit GC660 during the 2005-2006 academic year. As is common in medical schools and academic medical centers, our motto is: "learn one, do one, teach one".

Student Support by the Teaching Assistant

The teaching assistant's role evolved in several stages, first during the 2 offerings of the transitional 1-credit course, and then during the 1st 2 offerings of the enhanced 3-credit course. During the 1st offering of the transitional course in the Winter of 2005, the professor (Winter) experienced several issues that detracted from the instructional mission, a problem that was exacerbated by the fact that the class lasted only one hour. The BWG realized that, in order to make the course truly valuable to the students, and successful in terms of the university's academic mission, the instructors would need a teaching assistant (TA). The TA's role would be to address the following tasks and issues:
- navigating through SAS/EG
- importing data, i.e., from Excel and Access
- analyzing data using the Tasks List
- managing data using the Tasks List
- trouble-shooting EG errors
- solving statistical problems, including both in-class examples and homework problems
- providing assistance with installation on home PCs
- serving as an additional resource for students to contact for help while using EG at home

Uses of Blackboard Software

Thomas Jefferson University employs the Blackboard Academic Suite™ (6.3.1.505), including the Blackboard Learning System™ and the Blackboard Community System™, for web-based instructional support. General uses of Blackboard include posting documents, e.g., syllabi, Powerpoint presentations for lectures, homework assignments and homework problem solutions, test problem solutions, grades, email, etc.
Our innovative uses of Blackboard software included:
- a Troubleshooting "Discussion Board"
- Virtual Instructor Office Hours

Troubleshooting "Discussion Board"

As mentioned above, the TA provides trouble-shooting support. This support goes beyond today's standard telephone and email exchanges and "in-person" support. The students access most of their academic information using Blackboard[TM], which includes a discussion board function. The discussion board enables the TA, as well as students, to post messages and instructions in response to different issues. The messages are posted in chronological order and can be grouped into threads, which are also ordered chronologically. Also, users can add attachments to their posts to provide details on particular errors or feedback on how to resolve issues. It was interesting to find the students providing support to each other when one person previously encountered the same issue.

Virtual Instructor Office Hours

While it was hoped that this innovation would be popular with students, given that it would obviate the need for students to travel to visit the instructors, virtually no students opted for this approach.

EG Tasks Covered

Given that this is an introductory biostatistics course, only a small range of basic statistical analysis tasks were covered by all of the instructors:
Describe: One-Way Frequencies, Summary Statistics, Table Analysis
Graph: Bar Chart, Box Plot
ANOVA: t Test

On the other hand, one instructor (Crawford) felt that students needed training in data management as well as analysis and, thus, provided training in additional data management tasks:
Create New Items in Project: Create Data Using Data Grid, Create Query Using Active Data

The same instructor also elected to expose students to analysis of variance, using:
ANOVA: One-Way ANOVA, Linear Models, and Mixed Models.

IMPLEMENTATION RESULTS

We have evaluated the success of the EG implementation to date by examining several outcomes:
- Student performance in the 7 biostatistics courses offered thus far
- increased use of SAS/EG beyond the biostatistics courses per se
- students' preparation for MSPH clerkship and thesis opportunities

Student Performance in Biostatistics Courses

Students' performance post-EG implementation, as measured by both overall grades and more subjective faculty evaluations, has been at least as good as, if not better than, their pre-EG implementation performance. Evidently, allowing students to use software instead of performing calculations by hand or with calculators, has allowed both faculty and students to devote more time and effort to statistical theory, examples, and applications rather than manual calculations.

Increased Use of SAS/EG and Other Software in Graduate Courses

In addition to the vastly increased student experience with SAS/EG, described above, there have been several developments, at least indirectly related to the SAS/EG implementation and/or use of the existing electronic classroom "infrastructure":
- Some students have used SAS/EG to solve homework problems and complete assignments in other MSPH courses, even though use of SAS/EG is not yet a formal requirement in those courses.
- SAS/EG and the electronic classroom have been used for specific lectures and/or demonstrations in several other MSPH courses, i.e., Health Services Research.

MSPH Theses

BWG members (Lofland, Diamond, and Crawford) have supervised at least 2 students who have received their MSPH degrees after using SAS/EG for the data analyses in their theses, and these faculty are currently supervising at least 5 more MSPH students analyzing data and writing theses.

CONCLUSION

Thomas Jefferson University recently implemented SAS/Enterprise Guide (EG) software to upgrade the biostatistics curricula of its Public Health and Pharmacology Master's programs. Its Biostatistics Working Group (BWG), convened in 2004 and comprised of all faculty teaching graduate biostatistics courses, evaluated 3 statistical packages and selected and implemented SAS/EG. The implementation involved an expanded site license, collaboration with Academic Information Services and Research (ASIR) staff to revise the electronic classroom PC image, and collaboration with SAS Institute, Inc. and ASIR staff to develop a student home use agreement. Thus far, 3 faculty and 1 teaching assistant have taught 7 courses and more than 125 students. Students have learned how to use EG to perform data management and statistical analyses such as t-tests and chi-square tests. A number of faculty and students have used EG in other courses; and several students have used EG to perform the data analyses in their Master's theses. The key technical challenges have been providing effective remote support to students whose home PCs employ a variety of hardware platforms and operating systems, and maintaining the integrity of the electronic classroom and home installations.

Our experience demonstrates that, with appropriate organizational commitment and support (i.e., by senior administration, faculty, and IT and library staff), and facilities (i.e., an electronic

classroom and a sufficiently robust network of PCs), graduate school biostatistics faculty can upgrade their curricula by enhancing students' Biostatistical software training and experience.

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