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SAS® Skill Learning and Certification Preparation in a Graduate School Setting

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ABSTRACT

A semester-long course was created with the goal of teaching graduate students SAS® programming skills and to prepare them to take the SAS® Base Programming for SAS®9 exam. Course activities and materials include: weekly lectures; in-class labs; take-home problem sets; virtual (online) labs; assigned readings from the *SAS® Certification Prep Guide: Base Programming for SAS®9*; midterm and final exams; and access to SAS® OnDemand for Academics. This paper covers the details of the course development and design, as well as preliminary results from the course and plans for future developments.

BACKGROUND

In 2003, the faculty at the University of Pennsylvania's Graduate School of Education (GSE) approved an experimental section of the current course titled EDUC525: Data Processing and Analysis. In 2005, as a result of the positive feedback from the students and faculty at GSE, the experimental course was reclassified as EDUC625: Data Processing and Analysis (hereinafter referred to as EDUC625) and became an official graduate course on GSE's academic course roster. While the original course focused more generally on the use of various software packages to handle a range of data processing and analytic tasks, the reclassified course was revised to focus on offering a full semester of instruction using SAS® software.

During the Fall 2011 semester, an exploration of SAS's website led by the EDUC625 professor introduced the students to the SAS® Base Programming Certification exam. A group of graduate students from the EDUC625 course later expressed interest in taking the exam. The following Spring 2012 semester, these students, under the guidance of their professor, formed a virtual study group to work through the *SAS® Certification Prep Guide: Base Programming for SAS® 9*. Virtual bi-monthly meetings were held to review and discuss key concepts and information from the *SAS® Certification Prep Guide*. Several students aided in this process by typing out lists of key points from each chapter and creating slides, example programs, and other review materials for dissemination during the virtual meetings.

The study group made arrangements with SAS Institute to take the SAS® Base Programming for SAS® 9 certification exam on campus at the University of Pennsylvania on May 21, 2012. The group was able to take the exam at half of the full cost as a result of the academic discounts provided by SAS Institute. Only two of the seven individuals who sat for the exam, however, passed. This experience made it clear that in order to pass the exam, (1) more than just a review of the *SAS® Certification Prep Guide* would be needed to prepare adequately, and (2) the exam should be taken within two months upon reviewing the *SAS® Certification Prep Guide*.

Therefore, in response to the number of students interested in taking the SAS Base Programming certification exam and the actual experience of taking the exam, the course was revised by the professor and two teaching assistants to better prepare future course participants for taking the exam while still providing a solid foundation in SAS programming techniques and real world academic and professional applications.

COURSE DESIGN, MATERIALS, and ACTIVITIES

COURSE OVERVIEW

The course, currently listed at the University of Pennsylvania's Graduate School of Education as EDUC625, is aimed towards achieving two main goals: (1) to help students become proficient in using SAS software, and (2) to prepare students for the SAS® Base Programming for SAS® 9 certification exam. These goals are to be reached through hands-on experience with SAS software and through readings and discussions of the conceptual underpinnings of the software's processes. The purpose of these goals is to help students become more capable and responsible scholars and researchers, and for them to gain credibility and marketability as SAS users. As such, upon the completion of this course, students should be able to use SAS software to effectively interpret data for the conduct of statistical analyses, evaluate methods for dealing with real-world applications and issues, and apply contemporary statistical methods using SAS software.

The only prerequisite for this course is the successful completion of a graduate-level course in statistics (or an equivalent). For the Fall 2012 semester, the class has one professor, two teaching assistants, and 26 students. The class is comprised of current graduate students, mostly from the Statistics, Measurement, Assessment, and Research Technology master's program (of which the class is currently a core requirement) or other graduate programs in GSE, and working professionals who are taking the class outside of a degree program.

The class meets in person once a week for two hours in a computer lab at GSE and for one hour online using the GoToMeeting application and the SAS® OnDemand for Academics software. The class spans 15 weeks (i.e. one full semester). The *SAS® Certification Prep Guide: Base Programming for SAS®9 (Third Edition)* and *Learning SAS® by Example: A Programmers Guide* (Cody, 2007) are used as the textbooks for the class. The course follows the *SAS® Certification Prep Guide* and covers roughly two chapters per week.

READINGS

Weekly readings are assigned from the *SAS® Certification Prep Guide* and *Learning SAS® by Example* (Cody, 2007) textbooks. The reading topics follow the chapters as they are laid out in the in the *SAS® Certification Prep Guide,* with corresponding readings from *Learning SAS® by Example* (Cody, 2007). Typically, two chapters from the *SAS® Certification Prep Guide* are assigned each week. Students are expected to have completed the assigned readings before coming to the class meeting where the topics from those chapters are going to be the focus of the lecture and in-class lab.

LECTURES

The first hour of each two-hour class meeting is used for a lecture provided by the professor. The lecture covers information from the readings that were assigned during the previous week, highlighting key concepts and executing example programs on a projection screen in front of the class. During this time, students have the opportunity to ask questions and are asked to offer responses to questions posed by the professor in class. Lecture content is derived from material from the e-learning courses *SAS® Programming 1: Essentials* and *SAS® Programming 2: Data Manipulation Techniques* provided by SAS Institute as part of the University of Pennsylvania's academic software license, and from materials from previous semesters. There are 13 lectures scheduled during the semester. Attendance during lectures is not recorded or counted towards final grade.

IN-CLASS LABS

The second hour of each two-hour class meeting is used for in-class lab sessions. Labs are based on exercises found in the e-learning courses *SAS® Programming 1: Essentials* and *SAS® Programming 2: Data Manipulation Techniques*, and like the lectures, are based on the information from the readings that were assigned during the previous week. Labs are hands-on, and include activities such as editing existing programs or creating new programs to read in raw data sets, process data, and format output. Labs usually consist of three to six different "levels" containing their own unique tasks. Students each have to complete their own labs, but can discuss the labs with other students as they work. Students also have the opportunity to ask questions and get help from the two teaching assistants and the professor during this time. Any lab work that is not completed in class is completed during the week before the next class meeting. The SAS log file from each successfully completed level is emailed to the teaching assistants, who then review the students' logs and communicate with students via email if any revisions need to be made to their programs. There are eleven labs scheduled during the semester. In-class labs account for 10% of a student's final grade.

PROBLEM SETS

Each week, students are assigned a take-home problem set that is to be turned in at the beginning of the next class. Problem sets typically consist of ten SAS® Base Programming exam-style multiple-choice questions, sometimes with a few short answer or fill-in-the-blank questions. The content of the problem sets is based on questions from the e-learning courses *SAS® Programming 1: Essentials* and *SAS® Programming 2: Data Manipulation Techniques.* Problem sets are graded by a teaching assistant and then returned to students at the end of class. There are nine problem sets scheduled during the semester. Problem sets account for 10% of a student's final grade.

VIRTUAL LABS

The class meets online once a week for approximately one hour. The GoToMeeting software and SAS® OnDemand for Academics are the platforms used to communicate orally and visually in these online meetings. The teaching assistants lead each virtual lab meeting. This time is used to answer students' questions pertaining to anything covered throughout the course, such as questions about the in-class labs, problem sets, readings, exams, general SAS usage and applications, and administrative questions. This time is also used to review and to give further

examples of the concepts covered in the lectures and readings. Students call in using a phone or a computer with a microphone and speakers for the audio portion of the virtual lab, and use a computer to view the visual portion of the lab. During the lab, the students and teaching assistants can communicate either in the on-screen chat window or by talking on the call line. Attendance at the virtual lab meetings accounts for 5% of a student's final grade.

MIDTERM AND FINAL EXAMS

Students take a midterm exam halfway through the semester, and a final exam at the end of the course. The midterm and final account for 35% and 40% of a student's grade, respectively. The midterm is comprised of 50 SAS® Base Programming exam-style multiple-choice questions. The questions on the midterm are derived from questions found in the SAS® Certification Practice Exam: Base Programming for SAS®9 provided by SAS Institute as part of the University of Pennsylvania's academic software license, and the *SAS® Certification Prep Guide*. Students have two hours in class to complete the exam. For the final exam, students complete a take-home programming task similar to those completed in the in-class labs.

SAS® OnDemand FOR ACADEMICS

SAS® OnDemand for Academics is provided to students free of charge as part of the University of Pennsylvania's academic software license. As the usual cost of a license for SAS® can be cost-prohibitive for some individuals, having access to SAS® OnDemand allows students greater access to SAS® software, which may otherwise only be available to them in computer labs on campus.

RESULTS AND FUTURE PLANS

CLASS SCORES AND THE SAS® BASE CERTIFICATION EXAM

Scores on the midterm exam ranged from 69% to 100%, with an average score of 90% and a median score of 91%. Scores on the final exam ranged from 73% to 100%, with an average score of 95% and a median score of 98%.

About one month after the end of the course, on February 1, 2013, 11 of the 26 students from the course took the SAS® Base Programming for SAS® 9 certification exam. Ten of the eleven students passed the exam. The scores ranged from 50% to 93%, with an average score of 83% and a median score of 90%.

SAS® ADVANCED PROGRAMMING COURSE

A syllabus has been constructed for a similar course based on the *SAS® Certification Prep Guide: Advanced Programming for SAS®9 (Third Edition)* textbook that would prepare students for the SAS® Advanced Programming for SAS®9 exam. This course would be offered to those who have taken the Base Programming course or have demonstrated basic proficiency with SAS software. The course would cover topics including integration of SQL, macro processing, and advanced SAS programming techniques.

REFLECTIONS AND CONCLUSIONS

SUCCESSES THUS FAR

All but one of the students who took the SAS® Base Programming for SAS® 9 certification exam following completion of the new EDUC625 course passed. This leads us to believe that the goal to revise the curriculum to adequately prepare students for the SAS® Base Certification exam may have been achieved.

POINTS FOR IMPROVEMENT

The *SAS® Certification Prep Guide* covers a lot of programming concepts and techniques, and it can certainly be challenging to cover all of the material in one semester. Therefore, it is important for an instructor to be strategic in constructing a syllabus that strikes a balance between covering enough material for students to pass the exam and allotting enough time to cover all the essential material relevant to the exam within the semester.

The SAS course materials that we used as supplemental materials are not entirely aligned with the *SAS® Certification Prep Guide*; therefore, an instructor (and/or teaching assistant) will have to make an effort to align the materials accordingly. For example, some of the in-class labs that were developed from the SAS materials covered concepts like permanent SAS data sets in earlier sections that were not covered until later sections of the *SAS® Certification Prep Guide*.

It would be advantageous for the instructor (and teaching assistants) to sit for the actual exam themselves, to gain a better perspective in aligning the curriculum with the *SAS® Certification Prep Guide* and the SAS® Base Certification exam.

The current course could be enhanced by extending our reach across the University of Pennsylvania and by engaging with SAS users around the world. Such connections would support both the technical and professional development that are goals of this course, and would give the course developers the opportunity to give back to the University and the SAS community whose resources have helped contribute to the creation of this course.

It is hoped that other institutions could find the program that has been implemented at GSE to be both easy to implement and successful. This program could be suitable for almost any institution seeking to attain similar goals of SAS skill development and SAS® Base Programming exam preparation.

REFERENCES

- Citrix Online, LLC. (2012). GoToMeeting [Software]. Available from http://www.gotomeeting.com/fec/online_meeting
- Cody, Ron. 2007. *Learning SAS® by Example: A Programmer's Guide.* Cary, NC; SAS Institute Inc.
- Ensor, Michelle & Farmer, Susan. 2009. *SAS® Programming 1: Essentials Instructor's Guide*. Cary, NC; SAS Institute Inc.
- McAfee, Rob & Passarella, Kathy. 2009. *SAS® Programming 2: Data Manipulation Techniques Instructor's Guide.* Cary, NC; SAS Institute Inc.
- SAS Institute Inc. 2007. *SAS® Certification Practice Exam: Base Programming for SAS®9.* Cary, NC: SAS Institute Inc.
- SAS Institute Inc. 2011. *SAS® Certification Prep Guide: Advanced Programming for SAS®9, Third Edition.* Cary, NC: SAS Institute, Inc.
- SAS Institute Inc. 2011. *SAS® Certification Prep Guide: Base Programming for SAS®9, Third Edition.* Cary, NC: SAS Institute Inc.
- SAS Institute, Inc. (2012). SAS OnDemand for Academics [Software]. Available from http://www.sas.com/govedu/edu/programs/od_academics.html

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TRADEMARKS

APPENDIX

Schedule from Course Syllabus: *EDUC625* (Fall 2012)

Date	#	Topics	In-Class Activities	Items Due In Class
9/10/2012	1	**Course Introduction & Basic Concepts**	• Introduction • Review of syllabus • Learning Concepts of SAS Programming ▪ Introduction ▪ Referencing SAS Files ▪ The SAS Programming Workspace • Overview of SAS Programs ▪ SAS Libraries ▪ SAS Data Sets and Data Types • *In-class Lab #1* • *Problem Set #1 assigned*	• Read *SAS Certification Prep Guide* Chapter 1 • Read *Learning SAS by Example* Chapter 1
9/17/2012	2	**Referencing Files and Setting Options & Editing and Debugging SAS Programs**	• Introduction to Referencing Files ▪ Viewing SAS Libraries ▪ Specifying Results Formats ▪ Opening Sourced SAS Program • Overview of SAS System ▪ Setting System Options • Editing and Debugging SAS Programs ▪ Editing SAS Programs ▪ Interpreting Error Messages ▪ Correcting Errors ▪ Resolving Common Problems • *In-class Lab #2* • *Problem Set #2 assigned*	• Read *SAS Certification Prep Guide* Chapters 2 & 3 • Read *Learning SAS by Example* Chapters 2 & 4 • **Problem Set #1 due**
9/24/2012	3	**Creating List Reports & Creating SAS Data Sets from Raw Data**	• Producing List Reports ▪ Creating a Basic Report ▪ Selecting and Controlling Variables ▪ Manipulation of List Reports ▪ Formatting • Introduction to Raw Data Files ▪ Referencing Raw Data Files ▪ Creating a Raw Data File ▪ Reading In stream Data ▪ Reading and Creating Microsoft Excel Data • Introduction to the DATA Step ▪ Writing and Submitting a DATA Step Program ▪ Using the IMPORT Wizard • *In-class Lab #3* • *Problem Set #3 assigned*	• Read *SAS Certification Prep Guide* Chapters 4 & 5 • Read *Learning SAS by Example* Chapters 6 & 14 • **Problem Set #2 due**
10/01/2012	4	**Understanding DATA Step Processing & Creating and Applying User-Defined Formats**	• DATA Step Processing ▪ Writing Basic DATA Steps ▪ Processing SAS Programs • DATA Step Processing: Advanced ▪ Compiling and Executing DATA Steps ▪ Debugging a DATA Step ▪ Testing Programs • Introduction to User-Defined Formats ▪ Introduction to PROC Format ▪ Association with Variables • *In-class Lab #4* • *Problem Set #4 assigned*	• Read *SAS Certification Prep Guide* Chapters 6 & 7 • Read *Learning SAS by Example* Chapter 5 • **Problem Set #3 due**
10/08/2012	5	**Producing Descriptive**	• Computing Statistics ▪ Computations Using PROC MEANS	• Read *SAS Certification Prep Guide* Chapters 8 & 9 • Read *Learning SAS by*

		Statistics & Producing HTML Output	▪ Group Processing
			▪ Creating a Summarized DATA Sets
			▪ Introduction to PROC FREQ
			▪ Creating Tables (two-way, n-way)
			● HTML Output
			  ▪ Creating HTML Output
			  ▪ Intro to the Output Delivery System (ODS)
			  ▪ Appearance of the HTML Output
			  ▪ Additional Features
			● *In-class Lab #5*
			● *Problem Set #5 assigned*
				Example Chapters 16, 17 & 19
				● **Problem Set #4 due**

10/15/2012	6	**Creating and Managing Variables & Reading SAS Data Sets**	● Variables: Extended
			  ▪ Creating and Modifying Variables
			  ▪ Assigning Values
			  ▪ Grouping Statements
			● SAS Data Sets: Extended
			  ▪ Reading Single Data Sets
			  ▪ Manipulating Data
			  ▪ BY-Group Processing
			  ▪ Detecting the End of a Data Set
			● *In-class Lab #6*
				● Read *SAS Certification Prep Guide* Chapters 10 & *11*
				● Read *Learning SAS by Example* Chapter 7
				● **Problem Set #5 due**

10/22/2012	**7**		**Midterm Exam**	

10/29/2012	8	**Combining SAS Data Sets & Transforming Data with SAS Function**	● Combining SAS Data Sets
			  ▪ Types of Merging
			  ▪ Excludes
			  ▪ Selecting Variables
			● Introduction to SAS Functions
			  ▪ Modifying and Manipulating Values
			  ▪ Nesting SAS Functions
			● *In-class Lab #7*
			● *Problem Set #6 assigned*
				● Read *SAS Certification Prep Guide* Chapters 12 & 13
				● Read *Learning SAS by Example* Chapters 10, 11 & *12*

11/05/2012	9	**Generating Data with DO Loops & Processing Variables with Arrays**	● Using DO Loops
			  ▪ Constructing DO Loops
			  ▪ Iterative Processing
			● DO Loops: Advanced
			  ▪ Conditional Clauses and Executions
			● Working With Arrays
			  ▪ One-dimensional Arrays
			  ▪ Uses of Arrays
			● *In-class Lab #8*
			● *Problem Set #7 assigned*
				● Read *SAS Certification Prep Guide* Chapters 14 & 15
				● Read *Learning SAS by Example* Chapters 8 & 13
				● **Problem Set #6 due**

11/12/2012	10	**Reading Raw Data in Fixed Fields & Reading Free-Format Data**	● Raw Data in Fixed Fields
			  ▪ Review of Input Styles
			  ▪ Using Informats
			  ▪ Working with Record Formats
			● Free-Format Data
			  ▪ List Input Style
			  ▪ Creating Free-Format Data
			  ▪ Mixing Input Styles
			● *In-class Lab #9*
			● *Problem Set #8 assigned*
				● Read *SAS Certification Prep Guide* Chapters 16 & 17
				● Read *Learning SAS by Example* Chapter 3
				● **Problem Set #7 due**

11/19/2012	11	**Reading Date and Time Values & Creating a Single Observation from**	● Date and Time Values
			  ▪ How SAS Stores Date and Time Values
			  ▪ Reading Dates and Times with Informats
			  ▪ Using Dates and Times in SAS
				● Read *SAS Certification Prep Guide* Chapters 18 & 19
				● Read *Learning SAS by Example* Chapters 9 & 21
				● **Problem Set #8 due**

		Multiple Records	▪ Single Observations from Multiple Records ▪ Introduction to Line Pointers ▪ Reading Multiple Records (Sequentially and Non-Sequentially) ▪ Line Pointer Controls ● *In-class Lab #10* ● *Problem Set #9 assigned*	
11/26/2012	12	**Creating Multiple Observations from a Single Record & Reading Hierarchical Files**	● Multiple Observations from Single Records ▪ Repeating Blocks of Data ▪ Reading Numbers of Repeating Fields ● Hierarchical Files ▪ Creating One Observation per Record Types ▪ DATA Step: Observations per Header Record ● *In-class Lab #11*	● Read *SAS Certification Prep Guide* Chapters 20 & 21 ● Read *Learning SAS by Example* Chapter 23 ● **Problem Set #9 due**
12/03/2012	13	**Review/Catch-up/Advanced Topics Introduction**	**Take-Home Final Exam Assigned**	
12/10/2012	14		**In-Class Final Exam**	