Using SAS/AF® Software to produce support materials for statistics - a case study from higher education

Noel Wilson and Sally McClean
University of Ulster, Northern Ireland

Abstract

This paper describes the educational and project management aspects of a computer-based tutorials (CBTs) development project in support of SAS statistical software. Design considerations associated with the CBTs are described in detail and the background to the project is also outlined. Development work was undertaken in close collaboration with SAS (UK) personnel, who provided important technical and quality audit input to the project; relevant features of this development partnership are also documented.

Introduction

This project forms part of a wider project undertaken at the University of Ulster under the auspices of the Universities Funding Council (UFC) Information Technology Training Initiative (ITTI), which is sponsoring United Kingdom (UK) Universities to create products in support of end-user training in Information Technology [1]. The project at Ulster provides a suite of CBTs, and associated documentation, to support statistical analysis undertaken by staff, postgraduates and students within the institution. Emphasis is placed on the need to create products which are appropriate for use by advisory and training staff employed within the Computer Centre; this is an objective of the ITTI scheme. Furthermore, a modular course on Research Methods, administered by the Staff Development Unit (SDU) of the University provides a suitable basis for CBT content and delivery style. This course includes several short modules on aspects of statistics and computation which are specifically designed for a target audience without a mathematical statistics background yet having a requirement to undertake statistical investigations. An intuitive approach to presentation of relevant theoretical material is used in conjunction with workshop style activity involving the use of computer software, and this model of delivery is being adopted in the CBT design. In the following sections further detail is presented on the Research Methods course including an overview of the module on SAS; the development of product specifications to encapsulate target audience requirements and the product production process is addressed in detail.

Support for statistical applications

Our Research Methods course was designed, approximately 8 years ago, to meet the requirements of the University research community (staff and postgraduate research students) following the merger of the, then, New University of Ulster and Ulster Polytechnic to form the newest UK University prior to the removal of the "binary divide" in higher education (HE) in 1992. The new institution identified a

370
need to improve its contribution to research activity and it was decided that core competency skills in support of research should be delivered through this modular course structure. Modules relevant to statistical investigation included:

- Statistical Computing using SPSS
- Inferential Statistics
- Descriptive Statistics
- Scale Construction
- Regression Modelling.

These are offered annually, subject to demand, although in the initial year of the course it was necessary to run all modules twice. Duration of modules is typically two by 1 day blocks although some only require 1 day.

SAS statistical software has only been introduced to the applications software service provided by the Computer Centre during the 1991/1992 academic year in the form of the pc product, for MS DOS platforms. Other statistical packages centrally available include SPSS (including the Graphics and Tables options) on VAX/VMS and MS DOS platforms, Minitab on VAX/VMS and MS DOS, and TSP on VAX/VMS. Demand for SAS was initially identified through placement work undertaken by BSc Mathematics, Statistics and Computing students, although there is now further interest in the product including econometrics teaching at postgraduate level. Given the wide range of modules available in the SAS pc implementation, especially the matrix manipulation functionality offered by SAS/IML® and the operational research techniques available in SAS/OR®, the Computer Centre is taking active steps to further promote software usage. Implementation of the statistical modules on a SUN UNIX service is also being considered.

A key feature to the successful implementation of any new service is end-user training and for SAS this is no exception. The timing of the acquisition of the product coincided with the award of our ITTI grant; indeed the original project proposal was extended to incorporate the SAS product with additional funding allocated by the grant awarding body, UPC. (In Northern Ireland payment is made by the Department of Education for Northern Ireland [DENI] upon receipt of a recommendation from UFC). SAS (UK) Ltd was approached and invited to seriously consider provision of suitable support for this new component of the ITTI project. (Initially, the company was in contact with the ITTI directorate regarding training provision for its product range.) In particular, interest was expressed in obtaining training in the use of SAS and in being given the opportunity to review and discuss current SAS Institute training services for the academic community. A partnership was established to facilitate the production of the products described in this paper.

A major consideration in end-user support services for SAS® software was that of identifying a mechanism for integrating the product with existing complementary services. For example, SPSS usage is highest of all applications software usage on our VAX services, closely followed by MINITAB. Use of these products on pc systems and through servers to networked pc laboratories is also significant. Both products are well established in the University with a high degree of penetration within teaching and research across Faculty boundaries. From the outset it has been
acknowledged that SAS will be a minority user product in the field of general statistical application, therefore its promotion will depend upon the creation of an effective training service to enable existing statistical software users to readily interchange between products.

The need to consider the SAS environment, SAS-specific terminology and a range of "high demand" descriptive and presentation statistics techniques became obvious features in any proposed training product. An introduction to the SAS environment in effect constitutes a foundation level training requirement with basic statistics being one of several possible optional modules. By adopting this modular approach to training service provision it is possible to introduce further new modules to address emerging needs as growth in interest in the software continues. Furthermore, these basic areas of training requirement are at a level which is consistent with services currently on offer for other products, through the Research Methods course and Computer Centre advisory desks.

Topics addressed by the proposed training products include the following:

(a) **An Introduction to the SAS System**

- principal SAS Windows (OUTPUT, LOG and EDITOR)
- important hot-keys and Window management commands
- design, input and running of a simple SAS job
- SAS program structure (DATA and PROC steps)

(b) **Generating descriptive Statistics using the SAS System**

- basic theoretical considerations associated with elementary statistical investigation
- features and use of procedures of `gchart`, `freq` and `univariate`.

Having received approval for the inclusion of a new module on "Introductory Statistical Analysis using the SAS System" within the Research Methods course it was necessary to proceed with product development for which ITTI approval had already been granted.

**PRODUCT DESIGN CONSIDERATIONS**

Traditionally Research Methods modules have been presented in a conventional manner, using audio-visual and computer facilities appropriate to the requirements of each module. However the demands on time available to academic and research staff has made it difficult to offer the course at times which guarantee optimal attendance levels. A further objective of an ITTI project is to offer the course on a "self-teach" or "independent learning" basis. The ability to address this issue in parallel with providing computer-based support tools to enhance conventional delivery methods, and to assist Computer Centre staff with advisory and consultancy work offered an ideal opportunity to improve support for research within the institution.
Computer-based training is a widely used service which has demonstrated its effectiveness in industry and education and has been shown to provide a sound basis for the issues under consideration. As in most, if not all, training situations the need for supportive documentation also existed. The provision of a product which included a CBT and associated user documentation, typically Student User Guide, Workbook and Installers and Administrators Notes, was accepted as a suitable format.

**CBT FEATURES**

Use of the computer as a tool for independent learning can only be effective if the benefits of the tool are significantly better to those afforded by alternative technologies, in this case, course notes and workshop style presentations or in the case of the advisory service, face-to-face consultations. Undoubtedly users prefer face-to-face consultations particularly when an experienced person is filling the role of the advisor but the cost of such a service is a major constraint on its provision.

The University has been associated with computer assisted learning projects and use of the computer in teaching from the early 1970s and has accumulated a wealth of experience in good design principles.

For this particular project the design team considered it important to incorporate:

- drill and practice sessions
- simulation concepts
- graphics including animated sequences
- performance assessment.

The criteria for selection of the above feature were based on principles of good pedagogic practice. Drill and practice is an excellent method of subject reinforcement; when incorporated in a CBT it helps to create an opportunity for user participation in their learning process. Simulation is known to offer an inexpensive way of dealing with situations which are costly to provide in a "live environment", but it also is useful in facilitating training in a controlled microworld; in this case simulation of software command input is provided in an environment where erroneous input can be intercepted and dealt with in a fashion which is suitable for novice users. Text as a medium for delivery of subject matter becomes tedious especially if large volumes of information are involved. Incorporating graphics enables the CBT designer to provide variety and to present information in an optimal mode - explanation via graphics can be more effective than a paragraph of text. The extension of graphics to animated sequences enables CBTs to inherit a further mode of subject presentation; some authors considering the inclusion of simple animated sequences to merit the use of the term "multimedia" to describe the product. Any form of "self-paced learning" or "independent learning" resource should include a facility to enable its user assess their performance. In the case of the CBTs we have developed, a basic "test and report" management module is included.

The user interface is designed around the concept of consistency in information
presentation. Of particular relevance to this design consideration are:

- use of colour
- location of specific interface attributes on screen
- availability of help text and appropriate error diagnostics
- definition of navigation aids eg next/previous screen.

Technical considerations associated with user interface design are described in detail, by Cantley, in a paper which addresses the use of SAS/AF as a CBT design tool.

The use of a dataset which contains a suitable range of variable types was also an important consideration at design stage. Typically it is essential to allow the user to become familiar with the dataset employed by the CBT, as the association between analysis and variable type (nominal, ordinal, interval, ratio) is a key element of basic statistical investigation. Use of the dataset includes the provision of illustrative examples, say, of command lines; tests of user comprehension of command syntax by requesting the input of a command to undertake specified analysis on a particular variable or range of variables; and to facilitate further exercises as included in the student Workbook.

Style of user interaction was a further CBT design consideration. Interaction features in several characteristic ways; for example the use of simulated interaction with the SAS statistical product (SAS/Graph and Base SAS) provides a managed practice environment for new users. In the presentation of materials on the SAS software interface a simulation of moving between OUTPUT, LOG and EDITOR Windows is included.

Exercises are mainly based on multiple-choice question banks with user selection of appropriate answers implemented using arrow keys to navigate to their selection, and entering an 'X' character to denote selection. Some examples include multiple correct answers in addition to the conventional single correct answer variety. The rationale behind this feature is to impress upon the user that many problems can possess alternative correct solutions. For example, in software there are many instances where particular tasks can be performed using a range of commands.

Other exercises are based on the "fill-in-the-blank" principle, these are useful in conjunction with a background which resembles a typical screen of the parent application. Typically, this mode of interaction has been incorporated to test understanding of commands which are associated with Windows management operations.

**USE OF SAS/AF**

SAS/AF was an obvious choice of development language for CBT production as the task was essentially one of creating a user-friendly interface to a sequence of applied and theoretical subject matter. Furthermore, the capability of accessing other components of the SAS system through SAS/AF enables the designer to call upon,
for example, graphics and screen design modules. Alternative software production tools for CBT development have been used at Ulster, including Hypercard (for Apple Macintosh systems) and Guide (for MS DOS systems), but the ability to employ a product from the same supplier as the statistical software under consideration offered further opportunity to become familiar with SAS software services. CBTs using SAS/AF, created by SAS Institute, were made available to illustrate the capability of the product, and technical support was provided from the SAS (UK) support service. The ability to create highly interactive tutorials with good input/output capability was an essential requirement to enable the implementation of the features referred to already; SAS/AF proved to be well suited for the task.

Further technical considerations associated with SAS/AF are covered in detail by Cantley. Other authors have also proved the value of SAS/AF in applications development, for example Crawford commends the efficiency of the screen control language (SCL) in creating Clinical data Applications; and Sköllermo refers to the capabilities of the product in developing "foolproof" menu systems for specifying complex selection criteria. Hallmark Cards, Inc refer to the flexibility of SAS/AF in providing in-house solutions and their popularity among senior managers; this organisation has developed a major revenue forecasting product using SAS/AF.

Use of SAS/AF to create CBTs for other SAS software modules is also possible and it may well be appropriate to extend our existing project to deal with the SAS/OR and SAS/IML modules. IML is of particular value as it enables the user to create, from first principles, the basics of many multivariate statistical methods. Multiple linear regression and its associated tests for outliers in the dataset is a specific example of usage. Operational research topics also feature in several courses including business and management-related degree programmes. The ability to develop CBTs to illustrate the steps in, say, a linear programming solution using the Simplex technique could be of benefit to such courses, in the context of "self-teach" support materials. Indeed SAS/AF coupled to appropriate other modules provides a fertile area for final year project work, as already there are several students who undertake CBT type projects using tools which do not offer as high a degree of flexibility.

**PRODUCT DEVELOPMENT AND PROJECT MANAGEMENT**

*Overview of Product Development Stages*

Given that the University of Ulster was not a SAS site prior to the introduction of this project it was through necessity that suitable training was sought for the software developer. Initial training was obtained through attendance at a residential course and was followed up through independent learning and maintaining contact with SAS personnel assigned to assist with the project.

The product development scheme adopted by the project team consisted of a series of key stages which resemble those traditionally associated with software production, as shown below:
<table>
<thead>
<tr>
<th>Key Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assessment of requirements</td>
</tr>
<tr>
<td>2</td>
<td>Production of Outline Specification</td>
</tr>
<tr>
<td>3</td>
<td>Production of Detailed Specification</td>
</tr>
<tr>
<td>4</td>
<td>Prototyping and end-user assessment</td>
</tr>
<tr>
<td>5</td>
<td>Documentation</td>
</tr>
<tr>
<td>6</td>
<td>Product Testing</td>
</tr>
<tr>
<td>7</td>
<td>Product Release</td>
</tr>
</tbody>
</table>

An associated time schedule was also established which identified resource allocations for each key stage and indicated junctures for formal contact with SAS personnel, and through them to the wider community. These junctures were strategically located along the development path so as to afford the project team maximum opportunity to seek and act upon user feedback. No attempt was made to constrain development by insisting that each stage became an element on a critical path, for example prototyping and documentation activities did overlap as the software product matured. Also internal contacts and the expertise of senior University staff assigned to the project provided a high level of confidence in, for example, specification content prior to release to the external contacts. Continuity of work was assured as a consequence, since work was at an advanced stage on the development of the Detailed Specification whenever feedback was received on the Outline Specification.

*Figure 1* provides an elementary illustration of the range of activities implied in the 7 key stages identified above.

**Project Management**

Production of the CBTs and associated support literature was undertaken in a period of approximately 18 weeks using approximately 13 man-weeks effort. The original Project Proposal clearly stated the human resource allocation and was accepted by the National Co-ordinator for the ITTI scheme; the requirement to adhere to deadlines was understood by each member of the project team, including SAS personnel.

*Figure 1* indicates relative allocations of resources to each key stage and identifies the instances when elapse time was allocated to external review, principally by SAS staff. Throughout the project there was close collaboration between the technical project manager (University of Ulster) and technical staff in SAS so as to ensure the smooth turnaround of "requests and responses".

During the "Assessment of Requirements" stage, collaboration with SAS staff preceded the event with an initial briefing meeting involving the software developer, the technical project manager and key SAS staff. This briefing provided a clear statement on the style and content of the tutorials; the University staff understood their particular needs and SAS staff were able to advise on the requirements of the wider academic community. User feedback at this stage, was predominately from within the University.
The "Outline Specification" was compiled to provide a general statement on content and style. Its compilation was undertaken in parallel with SAS software familiarisation by the software developer. Formal acceptance (verbal statement) was given by SAS. Production of a "Detailed Specification" was undertaken to create a specific statement on tutorial content and design features; from this document coding of the CBT was effectively an exercise in information organisation and presentation. Approval for this document was gained internally and, again from SAS. A structured walkthrough of the document was undertaken at SAS offices and involved the technical project manager and a senior member of SAS technical staff. SAS also sought comment from a select group of academics, whom they call upon for advice and direction regarding their services to the academic community.

Once CBT production reached the stage where the "look and feel" of the user
interface was evident, the prototype was evaluated qualitatively within the University before being released to SAS. Feedback enabled minor refinements to be incorporated and a second prototype was dispatched, to SAS, where an extract was made for incorporation in a live display at SASVille, the SAS (UK) major trade event which was held in London in June 1992. This well attended event was an invaluable forum at which to launch the ideas of CBT products in support of SAS software usage. Whenever the initial tutorial, "An Introduction to the SAS System", was at final test stage a 1-day technical presentation was made to SAS staff at their Marlow offices. This event, which included a detailed interactive demonstration of the product, created an opportunity to solicit feedback from other SAS staff who were not previously associated with the project. Independent assessment of the project was considered to be a useful bonus in terms of product testing and evaluation. Upon completion of these trials, and the delivery of support literature, product development had reached a stage where input from a wider evaluation group was necessary. Further internal evaluations were requested, involving Computer Centre staff, but SAS also undertook to solicit views from academic community contacts. No significant issues, in terms of product inadequacy were identified and the robustness of the user interface was also confirmed.

Before proceeding to product release a set of packs (both CBTs and associated documentation) were distributed to selected University sites with an invitation to review the product. These sites were chosen on the basis of personal contacts. Our external academic assessor also was involved in final testing of the product, in addition to participating in earlier phases. Her role was principally to ensure appropriateness of CBT content, including presentation and other pedagogic aspects. Delivery of the fully validated package to the Universities Staff Development Unit (USDU) at the University of Sheffield signified the final phase of product delivery to the wider academic community. The product has now been officially available for 2 months; evaluations will continue with a second release expected before the start of the 1994/95 academic year.

Project management of the various stages was not a straightforward exercise as the software developer was a member of our full time staffing complement, due to lengthy delays experienced in recruiting a suitably qualified Research Assistant/Officer. This member of staff was expected to continue supporting academic computing through involvement in advisory and consultancy duties, although the latter was somewhat curtailed. The influence of extraneous variables in an academic setting can be significant as their demand profiles are difficult to predict. Resource allocation was conducted using a simple model whereby annual leave entitlement and support for other staff was assigned a constant value throughout the project timetable. The initial period was also biased towards staff development work on the SAS system as the product had only been introduced to the University; also an estimate of time for replies from external and internal reviewers was incorporated, at the conclusion of key stages as illustrated in Figure 1. This method of manpower allocation was realistic and indeed effective especially during all stages, excepting Product Testing and Product Release whenever there was a much more demanding call on resources beyond the control of the technical project manager. All other phases of the project were executed as initially scheduled with the strict control on involvement in unscheduled work playing an important role.
CONCLUSION

The opportunity to design a software training product in collaboration with a major software vendor has been rewarding; it has provided an excellent yardstick for quality assurance; it has enabled the product to acquire the "seal of approval" of the vendor at whose software it is aimed; it has enhanced the opportunities for prototyping and for professional review of all aspects of design and development, and now offers the potential for increased marketing and publicity.

As training services are currently capturing a significant level of attention, both within and outside the University sector, it is natural to assume that a partnership, as described in this paper, is of mutual benefit to those concerned and affords improved opportunities for product revision and future product development.

Given that the products have just been formally released to the UK academic community, we are now in a period of assessment of demand for, and wider acceptance of, the work which has been completed. Feedback will help inform the future although it is expected that further similar partnerships may be possible given the breadth of facilities offered by SAS products.

ACKNOWLEDGEMENTS

The authors of this paper wish to acknowledge the funding body which has enabled the project to be undertaken; the generous input of consultancy from various SAS (UK) Ltd employees, including Tony Blake, Bruce Bovill, Colin Harris and Ian Sedgwick; other SAS support including training and documentation; the efforts of Ian Cantley, University of Ulster, author of the products, and all others who have assisted the project, too numerous to mention individually.

Address for correspondence (first author):
Educational Services, University of Ulster, Shore Road, NEWTOWNABBEY, County Antrim, Northern Ireland, BT37 0QB
Telephone: (+44)232-365131 extension 3141
Fax: (+44)232-362809
e-mail: QGHU21@UK.AC.ULSTER.UJVAX (JANET Network)

REFERENCES


6 Profiles - Hallmark Cards Implements Popular Revenue Planning System; SAS Communications, Vol XIX, No 1, First Quarter 1993, pp14-16.