

Research Paper

Statistical Training of Statistical Services Branch Staff

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Statistical Services Branch

Methodology Advisory Committee

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INQUIRIES

The ABS welcomes comments on the research presented in this paper.

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The role of the Methodology Advisory Committee (MAC) is to review and direct research into the collection, estimation, dissemination and analytical methodologies associated with ABS statistics. Papers presented to the MAC are often in the early stages of development, and therefore do not represent the considered views of the Australian Bureau of Statistics or the members of the Committee. Readers interested in the subsequent development of a research topic are encouraged to contact either the author or the Australian Bureau of Statistics.

STATISTICAL TRAINING OF STATISTICAL SERVICES BRANCH STAFF

Robert Clark
Statistical Services Branch

1. SUMMARY

Statistical Services Branch (SSB) will shortly be conducting a review of technical training of SSB staff. This training currently consists of several formal courses on survey sample design and estimation and time series analysis, some specific sectional “in-house training”, seminars and on-the-job training. The review will include an analysis of our current skills and skill gaps, the structure of our training courses, presentation methods and skills, and a plan for revising our training program.

A paper was presented to MAC in November 1998 on “Training of Methodologists in the ABS”. The 1998 paper was a thorough analysis of all training of methodologists, not just technical training in SSB. The purposes of this paper are:

- to summarise the current strategies for technical training;
- to list some emerging issues affecting technical training; and
- to suggest future strategies.

2. CURRENT STRATEGIES FOR TECHNICAL TRAINING IN SSB

The 1998 MAC paper discussed the training received by methodologists at different levels of experience (0–2 years, 2–5 years and 5+ years), and the issues in developing a decentralised team of methodologists. In 1998, SSB had about 20 staff each in the 0–2 and 2–5 year groups, and about 45 staff in the 5+ group. Methodology Division, of which SSB comprises the majority, had 80% of its staff in Canberra and 20% in state offices.

Survey Methods 1 (SM1) is the major technical training for SSB staff with less than 2 years experience. SM1 teaches the main elements of the design-based framework, including stratified, multi-stage and multi-phase sampling. For the past two years, the Survey Methods 1 course has included a four lecture time series module, covering the main concepts of ABS time series methods but not the details. Non-response, imputation and outlier treatments are not covered in this course.

The course consists of a one week intensive module and 3 hours of weekly lectures over the following 3 months. State office staff attend the one week module in person, and study the material remotely for the rest of the course, with support from their local supervisor and limited support from the lecturer. The participants are formally assessed through assignments, a project and a university-style exam.

Other technical training received by the 0–2 years group includes “in-house training” courses run by each section in the maths-stats program once or twice per year. These courses are generally about 3 days long, and cover topics specific to the section. Non-response and outlier methods are covered to some extent, with a practical not a theoretical focus. Practical issues such as common computer files are also covered in in-house training.

Other development methods for the 0–2 years group are the MD weekly seminar series, and to a lesser extent external courses and conferences. Time Series Section mainly uses on the job training and monthly research forums to develop staff in the 0–2 years group.

The Model-Assisted Methods (MAM) course is the major technical training for SSB staff in the 2–5 year group. MAM teaches the model-assisted framework, in particular the generalized regression estimator, in detail. Non-response and the model-based framework are also briefly discussed in the course. Time series methods are not covered by this course.

Writing professional papers are another means of technical development for staff in the 2–5 year group. This primarily means MAC papers, although there is also the option of ABS working papers or journal articles. Some staff in this group participate

in conferences but this opportunity is not available for the majority of staff in this group.

Reading of journal articles and scanning the statistical literature are development activities which are encouraged in principle, but not very widespread in practice.

Technical development for “5+ years” staff is primarily self-driven. Writing of professional papers are a very significant part of this development. These include conference papers, MAC papers, working papers and journal papers. Even staff not producing formal papers for external distribution may produce reports on technical topics for internal peer review. Staff in this group may also develop their own skills by presenting technical training courses such as SM1, MAM or in-house training.

Training of decentralised staff creates several challenges. State office maths-stats staff are in smaller units than Central Office staff, and so are exposed to less variety of work. For example, many state office methodologists work primarily on business surveys and have little exposure to household survey problems. State office staff also have less access to formal training. The SM1 one week module reduces this problem, however the remainder of SM1, MAM and in-house training courses are not readily available to state office staff.

The 1998 paper suggested several strategies to improve technical development in SSB:

- i. greater use of individual development plans;
- ii. increased presentation of formal and informal seminars by junior staff;
- iii. supervisors and staff to agree that a certain number of days each year will be spent on technical development (e.g. professional papers);
- iv. staff to identify methodological research and development projects to be included in their work program;
- v. central office staff to give seminars when visiting state offices and vice-versa.

3. EMERGING ISSUES AFFECTING TECHNICAL TRAINING

The following progress has been made on the 1998 action items listed above:

- i. Individual development plans are now included in many but not all performance agreements.
- ii. The weekly MD seminar series has continued but junior staff are not presenting more than in 1998.
- iii. A Research Bank has been set up to quarantine more time for relevant research projects.
- iv. No clear progress on this item.
- v. Central Office staff often present seminars when visiting state offices, however the reverse is rare.

The number of experienced staff (5+ years) is at a fairly high level of 39 staff. There has been an increase in the number of experienced EL1 (assistant director) staff. These are typically staff who have a wide range of technical and managerial skills and have worked in all areas of the branch. We are looking for development opportunities to keep this group interested and challenged.

There has been a decrease in the number of graduates in statistics in many universities. This has resulted in a lower level of recruitment in SSB. For example, a total of 131 graduates applied for the 2001 recruitment, compared to 259 applications for 1999. A possible implication is that future SSB recruits may have less academic background in statistics and so may require additional training in basic statistical theory. A scholarship scheme was initiated in 1999/2000 to encourage more students to take statistics courses and to promote the ABS as an employer of statisticians.

In the past SSB has hired graduates in both Central Office and State Offices. In 2002, graduates were only hired in Central Office with the expectation that some will want to return to their home state. SSB is planning to continue with this strategy of hiring graduates primarily or wholly in Central Office, with some moving to state offices after one or more years in Canberra.

Some alternative models for developing specialist technical skills were extensively debated in 2000 and 2001. One option was to have a specialist technical stream with a non-managerial career path. The eventual decision was to retain the current approach where advancement requires a combination of technical and managerial skills.

However, the APS6 criteria was modified to allow staff to place more weight on either their managerial or technical skills, provided applicants were acceptable in both areas.

Instead of a technical stream, a Research Bank scheme was introduced about one year ago. Staff nominate to work on research projects with clear relevance to the ABS, and

are given time aside from other projects to progress these projects. So far, four Research Bank projects have been approved. Two of these projects are nearly completed, with some success. The other two have been substantially delayed due to other work pressures.

Partly as a result of the Research Bank scheme, the demand for cross-project advice from technically strong staff has increased. SSB is considering introducing a “gatekeepers” scheme which has been trialled and adopted by the Analytical Services Branch (ASB). The ASB approach is:

- Each year, identify a small number of high priority fields.
- Assign a gatekeeper for each field who will then be given time to master the field and produce some outputs such as an annotated list of papers. Typically about ½ day or one day per week for six months will be allocated.
- The gatekeeper role finishes at the end of the six or 12 months, but the person would often act as a technical advisor on future projects.
- Relevant fields for ASB included multi-level modelling and analysis of complex survey data. Some relevant fields for SSB would be imputation and outlier methods.

The sampling component of Survey Methods 1 (SM1) course is currently being rewritten. The main goal of the rewrite is to use a more generalizable notation, along the lines of “Model-Assisted Survey Sampling” (Sarndal, Swensson and Wretman 1992). In the current notes, estimators are presented as applying to specific designs only, leading to a “recipe book” approach by students. The new notes will exploit the fact that there are only a few estimators and general principles which can be applied to a range of situations. This approach aligns with SSB’s strategic direction of promoting generalized estimation systems wherever possible.

The SM1 Review includes a statement of the objectives of the course, which is attached. Some errors and unnecessary complications in the sampling notes will be removed and the notes will be presented in a more readable format.

Objective 7 of MD’s strategic directions is to “keep abreast of developments in methodology (both relevant theory and international practice)”. A number of approaches for keeping abreast of the statistical literature have been attempted in SSB, including:

- Literature reviews on a topic or paper, not tied to a specific project. The review is usually presented informally to colleagues at a section meeting.
- Incorporating a literature review into all significant projects. Most sections have a research forum or regular presentations on current projects and these presentations will include a summary of the literature review.

- A Notes library database has been developed to support reading of the statistical literature and will be in use by the end of November 2002. Links or references to relevant books and papers will be added to this database as they come up, indexed by keywords. There will be a facility to add summaries of the papers and literature reviews of particular topics to the database.

Anecdotal evidence suggests that half of SSB read journals regularly, usually motivated by specific projects. Almost no staff scan the literature on a systematic basis.

4. SUGGESTED STRATEGIES FOR ENHANCING AND MAINTAINING TECHNICAL TRAINING

A number of strategies for redeveloping and maintaining SSB's technical training will now be outlined. These strategies are still at the proposal stage, and not all have been agreed or resourced.

Strategy 1: Survey Methods 1

SM1 will continue to be the primary technical training for all staff in the 0–2 year group. A time series component was successfully introduced in 1999 and the sampling component of the course is being rewritten to use clearer and more generalizable notation from 2003 onwards. SM1 will give SSB staff sufficient knowledge of basic design-based sampling theory to be the ABS experts on sampling. It will also provide a basis for staff to become expert in other aspects of survey methodology. The course will continue to make use of a one-week module if there are state office participants, however our current recruitment strategy means that there will be few or no distance participants.

An approach to continually improving and updating SM1 will be developed. Broad areas for improvement will be identified, and the lecturer will be given time for a short revision of the notes before each year's course.

Strategy 2: Model-Assisted Methods (MAM) course

The MAM course will be made more accessible to staff in both Central and State offices. The course will be run in 2002 and 2003 to meet the current high demand, which is due to the likely use of regression estimation in many business surveys. Options to make this course more accessible to state offices will be investigated, for example videoing lectures or running MAM as a reading course.

Model-based methods for time series are expected to be in greater use in the future. Some training may be appropriate in this area, either as part of MAM or as a separate course.

Strategy 3: HSM and BSM in-house training courses

Outlines of the in-house training courses for Household Survey Methodology (HSM) and Business Surveys Methodology (BSM) are attached. These courses are designed to train new rotations into HSM and BSM. In-house training covers methodologies which are needed for these sections, but are too specific to include in SM1 or MAM. These courses will be reviewed to make them more consistent with SM1 and MAM. A strategy for presenting and updating the courses will be developed.

Strategy 4: Modules for special techniques

There are a number of topics which are important to enough staff for training to be required but which are too specific to cover in a formal face-to-face course. A number of self-learning modules will be developed, along the following lines:

- Each module will have a plan for learning the topic. This will include reading several relevant journal articles (concentrating on review papers where possible), some exercises (preferably just refer to a textbook for these), and a practical exercise (e.g. Write a SAS program to calculate a GREG for a real survey data, calculate relevant diagnostics, write a short report).
- A participant (usually at least two years experience) would work through the material at their own pace, helped by a mentor.
- The initial creation of a module would be by a Research Bank project and the creator would become a mentor for the course. ASB's gatekeeper scheme will be used as a guide.
- Subsequent participants will search for recent literature (using & adding to the MD Library Database) and update the module as part of their learning plan.

Strategy 5: Seminars, workshops and conferences

MD has a weekly seminar series which provides development opportunities for presenters and listeners. Most seminars cover new developments, often with an introduction aimed at listeners unfamiliar with the topic. Some "review seminars" could also be used to give a broad overview of a field of methodology rather than new developments. Some examples might be outlier methods for surveys, confidentiality or household weighting.

Each section of SSB has a regular meeting (typically fortnightly), often including short informal presentations on current work or a relevant paper. These are useful development for the speaker and the section, particularly for less experienced staff. Informal workshops are often held to discuss technical issues and options for current projects. For example, a half-day workshop on testing and implementation of a GREG estimation system was very successful.

Conferences are useful to give an overview of emerging ideas in statistics and sampling and can give participants ideas for useful innovations in the ABS. Presentation of a conference paper is a good development opportunity for staff at all levels.

Strategy 6: Methodological panel

SSB have recently decided to form a “methodological panel” starting in January 2003. The aim of the panel is to provide strategic management of SSB’s methodological developments, in particular:

- To identify methodological issues across collections.
- To recommend research and other projects leading to strategic benefits and capability building of SSB.
- To recommend best or standard methodological practices.

The methodological panel will meet quarterly, and will manage the development of SSB’s corporate knowledge. This will lead into individual’s technical development, because the panel will identify strategic methodological topics, which would then become objectives of our technical training program. For example, the panel would help to identify topics for training modules (see strategy 4).

Strategy 7: Research Bank

The Research Bank enables staff to work on relevant research projects not associated with their current workgroup. The Research Bank will contribute to technical training in SSB because:

- Research Bank projects should develop staff’s research and technical skills as well as meeting the research need;
- Development of special training modules (see strategy 4) would usually be through a Research Bank project.

The Research Bank is still relatively new, and its impact has been limited by the small number of projects and the delays imposed by other project work. It is expected that there will be more Research Bank projects in 2003 and they will be more actively managed during the year.

Strategy 8: Ongoing technical development for staff in the 5+ group

Staff with more than 5 years of experience have special development needs. This group currently contains a larger than usual pool of experienced EL1s who have strong skills in a range of areas. Training for this group should be self-driven. Writing of professional technical papers is thought to be an excellent method of developing the skills of more senior staff. Other approaches include conference attendance, presentation of technical courses, developing and mentoring special training modules, giving seminars, and working on projects with a research component.

Strategy 9: Basic statistical training

Paragraph 16 mentioned that future graduates may have less academic background in statistics. Options include: setting up internal training on basic statistics; finding some appropriate external courses; and encouraging enrolment in part-time graduate diplomas in statistics. ACSPRI courses are useful to cover specific topics (e.g. bootstrap variance estimation, multi-level or loglinear modelling) which graduates may not have covered in their degrees, but are not sufficient to give a grounding in statistics to a non-statistics graduate.

5. ISSUES FOR MAC

Comment is sought from MAC members on all aspects of this report particularly the following areas:

- i. Are the current objectives and modes of delivery appropriate for SM1 and MAM?
- ii. Are the suggested strategies appropriate? Can you suggest improvements or other strategies?
- iii. Do you have any ideas on the development of our experienced staff, particularly experienced EL1s (assistant directors)?
- iv. Any thoughts on strategy 4 (specialised training modules)? Do you have any experience with this style of training?

APPENDIX

A. LEARNING SPECIFICATION FOR SURVEY METHODS 1 COURSE

A.1 Aim

To give methodologists the technical framework needed to be the ABS experts on survey sampling and time series methods.

A.2 Goals

Performance

To place a real world survey design or estimation problem into the design-based framework, find a potentially useful technique, and rigorously assess and modify it if required.

To judge and evaluate any approximations needed in applying methods.

To qualitatively understand advantages and disadvantages of the tools of survey sampling.

Standard

Participants will be required to meet assessment requirements as determined by lecturer at start of course.

Conditions

Participants have access to course material and reasonable access to the lecturer and tutor.

Target audience (in order of priority)

SSB graduates & MSC graduates.

Analytical Services Branch staff.

SMA with significant academic background in a mathematical discipline.

A.3 Corporate priority

Most new starters coming into MD have very little, if any exposure to the theory and practice of designing surveys to estimate descriptive statistics (totals, rates etc) for large populations. The sampling theory component of SM1 is a course designed to provide new starters with the theory and practical experience to understand (and if necessary extend) methods in use within MD.

All new starters in Statistical Services Branch in Central Office or Regional Offices are expected to participate in SM1.

A.4 Learning details

Mode of delivery

1 week full day lecture / tutorial

Chapters 1–5

CO – SSB:

1/2 day lecture / tutorial after first week

Chapters 6–12

1/2 day study per week

SO MSC:

1 day study per week

SO other

Duration

Approximately 40 days spread over 5 months.

Prerequisites

Knowledge of probability, statistics and linear algebra (matrix vector representation of linear regression) – course comparable to 3rd or 4th year mathematics course.

Assessment

Assessment will be through 2 assignments, a sample design project, plus mid-semester and final exams.

Relationship to other formal courses

ECS Internal training
HCS internal training
MAM

Courseware

Course notes
Freelance slides
Exercise Workbook

A.5 Instructional methods

Explanation
Examples
Exercise
Discussion

A.6 Learning facilities

CO:

PCs
Whiteboards
PC linked to screen projection system
Chairs
Tables

SO:

weekly emails from lecturer
weekly copies of slides / tutorial exercises & solutions

A.7 Chapter specific objectives

Chapter 0: Mathematical prerequisites

To introduce mathematical & statistical prerequisites for rest of course (linear algebra, calculus, probability), specifically:

- Taylor's theorem with remainder

- Constrained optimisation via Lagrange multipliers

- Random variables & vectors

- Expected value, Variance, Covariance, Variance–Covariance matrix

- Conditional probability & Conditional expectation

- Matrix – vector representation of least squares and weighted least squares equations

This chapter will be in the notes but will not be presented. Participants will be expected to be fluent in these methods prior to commencement of the course

Chapter 1: Introduction

To introduce:

- quality framework

- purpose of surveys

- census v sample

- types of collections

- design-based framework

- design = sample selection mechanism = probabilities of selection

- estimation

- outline of course

Participants should be able to understand:

- quality framework concepts

- purpose and limitations of surveys

- concept of design-based framework, in particular:

- strengths and weaknesses

- assumes full response

- requires known probabilities of selection

PART A: SIMPLE ESTIMATION

Chapter 2:

To introduce:

- Horvitz–Thompson estimator and its properties
- motivate π PS and stratification

Participants should be able to:

- understand how indicator random variables can be used to derive properties of HT estimator
- use indicator variables to produce estimates of proportions and subpopulation estimates

PART B: SAMPLE DESIGN

"Preliminary"

To introduce:

- concept of sample design as sample selection mechanism alone
- three types of design

Participants should be able to:

- understand sample design as sample selection mechanism (determinant of known probabilities of selection)

Chapter 3: SRS and other EPS designs

To introduce:

- Simple random sampling
- Number raised estimator as special case of HT estimator
- Variance of NR estimator
- EPS systematic sampling

Participants should be able to:

- solve estimation problems under SRS
- solve allocation problems under SRS
- solve estimation problems under EPS systematic sampling

Chapter 4: Stratification

To introduce:

- definition of strata
- guidelines in choosing of strata
- implication of independent selections within strata for variance estimation
- SRS within strata and allocation under this design

Participants should be able to:

- understand concept of strata
- reasons for choosing a particular stratification
- solve (simple) allocation problems with stratified SRSWOR

Chapter 5: Unequal probability of sampling designs

To introduce:

- Without replacement designs & Horvitz–Thompson estimator
- Fixed size designs and random size designs

Participants should be able to:

- construct simple estimators under WOR designs
- understand practical issues in selecting a general WOR design
- fixed size vs random size (Poisson sampling)
- understand practical issues with variance estimation under a general fixed size WOR design
- variance approximation using π_i only

*PART C: ESTIMATION USING AUXILIARY DATA**"Preliminary"*

To introduce:

- concept of auxiliary information
- types of auxiliary information (categorical & continuous)
- use of auxiliary information to create estimators with improved MSE (without going into detail)

Participants should be able to:

- understand what auxiliary information is
- understand the types of auxiliary information that exist
- understand its use to improve the quality of estimators

Chapter 6: Post-stratification

To introduce:

- use of Population counts at levels other than strata in estimation

Participants should be able to:

- understand how population counts at levels other than strata can be used in estimation
- construct estimators for for any type of post-strata for general sample design
- understand dangers of post-stratifying too finely
- understand unconditional vs conditional variance

Chapter 7: Ratio estimation

To introduce:

- use of single continuous auxiliary variable in estimation when:
 - a proportionality relationship holds within the population, or
 - different proportionality relationships hold within subgroups of the population
- special cases for SRS and stratified SRS

Participants should be able to:

- construct ratio estimators for a general WOR design
- solve estimation and allocation problems involving ratio estimation under SRS and stratified SRS
- know when ratio estimation should be used vs NR under SRS

Chapter 8: Regression estimation

To introduce:

- use of several auxiliary variables (continuous and/or categorical) in estimation
- weighted least squares fitting to motivate form of regression estimator

Participants should be able to:

- construct estimators using specified aux info for general WOR design
- understand issues with choosing appropriate auxiliary information

PART D: MULTI-STAGE AND MULTI-PHASE DESIGN

Chapter 9: Multi-phase design & estimation

To introduce

- the idea of multi-phase design as successive subsampling
- the use of auxiliary information at each phase to improve estimators
- two phase design and estimation with special cases in detail
- cost – variance tradeoff in collecting extra information for use in estimation

Participants should be able to:

- understand multi-phase design as successive subsampling
- understand how to use auxiliary information at each phase to improve estimators
- special focus on 2 phase ratio estimator
- set up cost / variance tradeoff problems for evaluating single phase vs two phase estimators

Chapter 10: Multi-stage design

To introduce:

- populations with hierarchical structure of units (PSU, SSU, TSU, ...)
- multi-stage design as successive subsampling through the hierarchy (PSU then SSU then TSU ...)
- situations in which multi-stage designs are preferable to single stage designs (household surveys)
- allocation problems of multistage design
- use of design effects to simplify allocation problems

Participants should be able to:

- understand concept of population with different levels of units
- understand when multi-stage may be preferable to single stage
- solve (simple) allocation problems of multistage design

PART E: OTHER TOPICS

Chapter 11: Repeated sampling

To introduce:

- theory and practical issues behind estimation of movement with list based surveys, illustrated by the cases of SRSWOR from a fixed population
- theory and practical issues with BLUE estimator of movement, illustrated by the cases of SRSWOR from a fixed population
- Concept of births, deaths & stratum flips in changing populations

Participants should be able to

- understand concept of rotating sample
- understand concept of BLUE
- understand BLUE depends on population quantities that must be estimated in practice

Chapter 12: Variance estimation techniques

To introduce:

- variance of nonlinear functions via Taylor series
- replicate variance estimation (for single stage and multi-stage designs)
 - multiphase, movements and changing populations not covered

Participants should be able to:

- understand the use of replication and Taylor series in producing variance estimates

(Time series component)

A.8 Qualifications to deliver the training

Lecturers

Must have technical knowledge beyond the content of SM.

Practical experience in both economic and household surveys desirable to relate theory to ABS practice.

Presentation skills of high order.

A technical leader in MD.

Tutors

Must have technical knowledge beyond the content of SM.

Practical experience in both economic and household surveys desirable to relate theory to ABS practice.

Presentation skills of high order.

In practice it is unlikely that anyone below the APS 6 level or with less than 5 years experience would be appointed.

(Time series component).

Training group size

MD's recruitment (about 12 per year – including ASB) plus external participants deemed suitably qualified.

Would like to keep one week module under 20.

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