

## DIAGNOSIS, PROVISION AND ASSESSMENT OF QUANTITATIVE SKILLS FOR MANAGERS IN LOCAL GOVERNMENT

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*Basic numerical and graphical skills give enormous returns and yet are sorely lacking in otherwise highly skilled personnel. Many local government managers find themselves unable to understand or utilise basic tools, such as aggregated indices, run charts, bar charts and histograms. ISRU has developed a sensitive and innovative training programme for Local Government Organisations (LGOs). It is presented as skills updating to avoid confrontation and includes relevant computing (spreadsheet) skills. The programme is aligned to competences recognised for LGOs and this encourages take-up by managers. The need for improved mathematical skills links sector skills councils, improvement charities and education. The Mathematics in Education and Industry (MEI) charity has developed a diagnostic tool which will be piloted in the LGO arena. Training programmes work best with realistic data and examples placed in context. Feedback is vital for continuous improvement and has played a significant role in the development of the programme.*

### BACKGROUND

By observation of the inability of highly skilled personnel to make use of summary statistics and graphical displays as well as the need voiced by personnel responsible for planning and preparing policies, it is clear that training in quantitative methods is desperately required. Mature members of a workforce needing to carry out numerical operations have different training requirements to school children, students and specialist quantitative analysts. Local Government Organisation (LGO) officers are typically well trained in their own specialties of planning, health or economics but have little formal training in statistics. Most are graduates with meagre recent numerical training. Increasingly they are expected to perform duties that require a competence in quantitative analysis that they do not possess. It is well known that there are issues in extracting facts from figures, see for example Moroney (1952). LGO officers need to face their own needs, their managers need to confront the issue, provision must be available and take-up has to happen before an improvement in the mathematical competency of the workforce can be achieved. The paper considers the diagnosis of the problem in the next section. A rather successful provision is described in the third section, followed by a review of the role of assessment and feedback in continuous improvement of the programme. The final section summarises the intervention and looks towards the future.

### DIAGNOSIS

The idea for this training arose from the disheartening reaction to a data summary and graph presented to technical managers who were highly educated but not numerically oriented or competent. The graph is shown in Figure 1 and gives the viscosity of 54 consecutive batches tested on receipt prior to use in a manufactured product. The graph is richly informative showing that some batches have the more favourable higher viscosity and some have a lower viscosity. The variability of the viscosity of different batches is non random in appearance and the values seem to be restricted to lie between two extremes. The graph prompts a number of questions, for example:

- What causes the step changes between low and high viscosity? Can it be attributed to different suppliers or to different brands or other sources of variation?
- Can the higher viscosity be maintained? The costs were the same for each batch and yet some batches have better characteristics. Can the customer ensure that all batches have the higher viscosity?
- Are batches with extra low viscosity re-engineered to increase their viscosity up to the lower level of 1.28? Is the cost of this uncertainty in quality passed on to the customer?

The lack of numerical expertise and competence in utilizing basic quantitative information in this example in the manufacturing sector was discussed at the expert panel of the North East Regional Information Partnership (NERIP) and it was agreed to explore the need for improved numeracy in the public service sector amongst local government officers. The exploration was also of interest to the Mathematics in Education and Industry (MEI) charity. The MEI Industry programme aims to improve mathematics in the workplace. MEI has developed a diagnostic tool to determine senior managers' expectations of their staff as regards numerical competence and ability to use quantitative information. The liaison between NERIP, MEI and the Industrial Statistics Research Unit (ISRU) as training provider, statistical consultancy and research unit, afforded an opportunity to address the problem and develop a solution. In particular it offered an opportunity to pilot the diagnostic tool with managers.

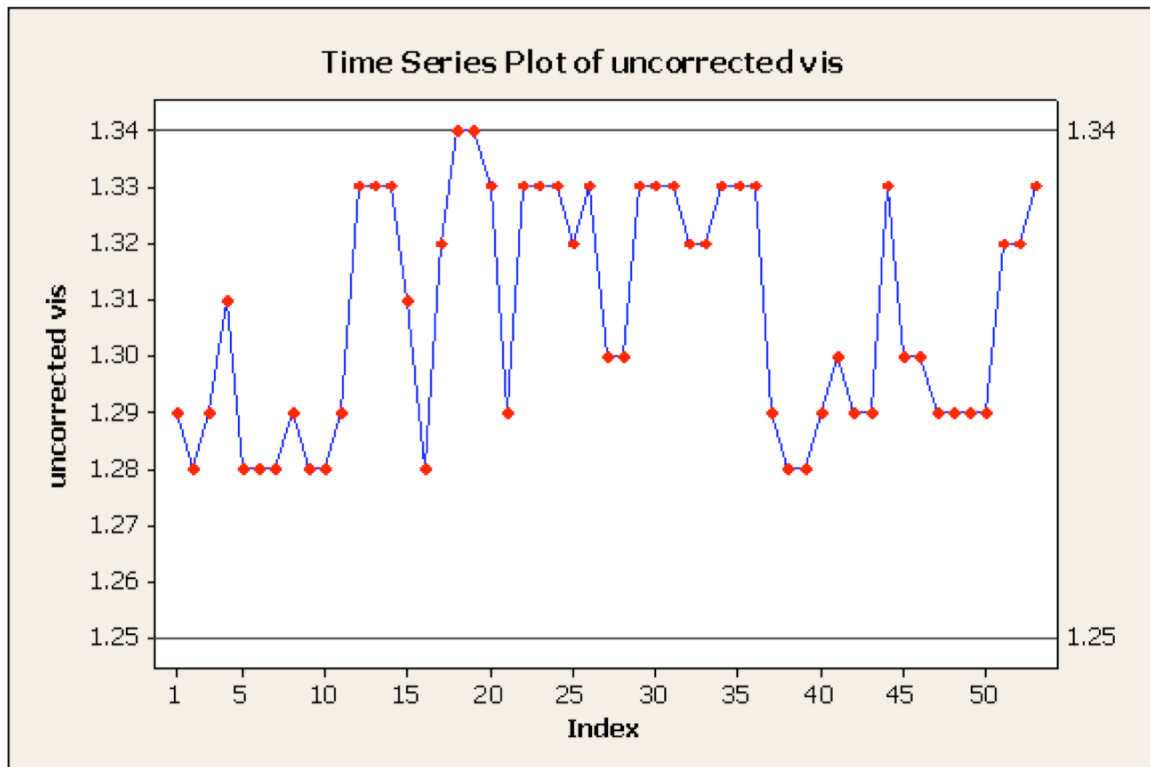


Figure 1. A richly informative graph – widely unappreciated

The work with LGOs and ISRU is at a fairly early stage and the first phases have focused on getting a basic provision up and running. It is envisaged that the diagnostic tool will be used when the initial nervousness of accepting help with numerical ability has been overcome.

The diagnostic tool was developed with a wide range of employers in mind including those in manufacturing as well as the service sector. The diagnostic tool starts off with fairly easy questions, such as “What is 3% of £5,000,000?” and managers are asked to give their opinion on how important it is for their staff to know how to be able to answer the question. The tool progresses to harder and harder questions and managers are asked to indicate when they have reached the limit of their expectations. Question 4, for example is:

*‘A nurse gives a hospital patient a drug at a drip rate of 2.5 ml per minute, using a 1000ml drip. The drip is started at 9am. At what time will all the drug have been administered?’*

The questions are accompanied by the following text:

*‘You are invited to consider how critical it is that people in your workplace can answer the question. Please tick the relevant box to indicate that:*

- a) It is critically important that our people can get the right answer*
- b) It is valuable if our people can get the right answer*
- c) It doesn't matter whether our people can get the right answer*

*We provide a space below each question for you to add any other comments that occur to you. If there is a related skill that does matter to you, please say what this is in the space for comments.'*

The unusual focus of the diagnostic tool onto the managers' expectations is innovative and useful because it encourages an exchange of knowledge between application and provider. It also promotes buy-in from the managers and this is vital for the viability of the programme as staff need to be released from duties to undertake training and training budgets are strictly limited so that managers need to be confident of the likely benefits before they will sanction attendance at the programme. Moreover, manager support is vital to make sure that staff can apply their new skills and that every possible support is given to them in terms of allocating appropriate tasks and initially allowing extra time for staff to complete the tasks.

As well as the top-down approach of the diagnostic tool, discussions with NERIP provided the opportunity for a bottom-up analysis of needs closer to the operational level. A focus group was held and revealed that the sort of issues staff felt worried about included a number of aspects of statistical literacy and innumeracy. For example, cascading central government policies to the local level were problematic. Central government may decide to implement a policy of no school class size exceeding 30 pupils and LGO staff may be asked to translate this into action in their domain. This requires a level of numeracy and competence not enjoyed by all staff. Other problems are associated with variation in small populations. For example, there may be a very small number of people in a certain category in a region, and if one of them loses his/her job, the unemployment rate in that category can jump by as much as 50%. Lack of understanding of sampling variation and confidence intervals can lead to misunderstanding and to a blame culture. Typically, special attention is given unnecessarily to random fluctuations causing waste of effort and resource and upsetting staff. The waste and upset could be avoided if numeracy levels are improved.

#### PROVISION

A training programme was devised which would answer the requirements of local government officers in the North East of England. Constructing a suitable programme is just one of several important issues including:

- how to attract people to the training
- how to satisfy the needs of the delegates
- how to ensure that the delegates sustain their improvement.

#### *Attracting people to the training*

There are two aspects to running a successful training programme:

- attracting the delegates
- attracting the senior managers to sanction the training.

Mature people, who are well thought of in their jobs, need to feel confident that accepting numerical training is not going to go against them in any way. The training was presented as a revision of skills previously known but forgotten through lack of use. People were therefore happy to attend the training.

Training needs to be aligned to core competences recognized in the job description of the employees. Hence there needs to be good communication between senior managers and training providers to ensure that the training meets all of the core competences for a range of jobs. Managers who are confident that the training will meet their needs are keen to release their staff for training. ISRU have worked with a number of standards setting bodies in the UK including SEMTA (the Sector Skills Council for Science, Engineering and Manufacturing Technologies). The competences for a type of job need to be described as a precursor to providing relevant training. The provision must be closely aligned with competences stated in local government requirements. Managers need to provide training to meet job competences but surprisingly a tailored quantitative methods course was not available off the shelf.

After several iterations, the popularity of the course required that further investment be made. The job went out to tender and ISRU was successful. Responding to feedback from past delegates and commissioning managers a multi stage approach is now used. Stage 1 is a 1 day briefing session where data are earmarked for use in stage 2, stage 2 is a 2 day training programme using delegates' data for the examples and practical sessions and stage 3 is a debrief and follow up session.

A six sigma design methodology, DMADV, is used to design training programme courses. Six sigma is a continuous improvement management initiative and DMADV is a five phase approach consisting of define, measure, analyse, design and verify. Continuous improvement methods include techniques such as statistical process control. The techniques can be used in many contexts, for example Roland Caulcutt notes that he once had to deliver a large number of similar courses to a multi national company and kept a SPC chart of the delegate feedback to help him keep track of his performance.

#### *Satisfying the needs of delegates*

Delegates need to see the training in the context of their job, hence it is very important to utilize examples based on their own work practices. Together with all students, adults like to have a training day with varied activities including different types of interaction, such as exposition, practical sessions, small group work, panel discussions and feedback. Some say the attention span of adults is about 20 minutes. The attention span of school children may be even shorter and Monkseaton High School in Tyneside is piloting an experiment with 8 minute lessons which appears to be working very well.

Trainees from different groups prefer rather different styles and the training has to encompass these preferences. The different work sectors of people who have received quantitative methods training are:

- local government managers
- healthcare managers
- university research and administration officers.

Practical work is very important to embed the training and skills. Context is provided by ISRU staff who carry out consulting as well as training and are hence in a unique position to provide this sensitive approach.

The topics dealt with in the training include aggregated indices, run charts, bar charts and histograms. One of the practical sessions employed is to ask the delegates to take a sample from a bag of different coloured sweets, and use the sample to estimate the weight and colour composition of the whole bag. This practical is very simple but can be used to demonstrate: bias because larger sweets are preferentially chosen; the use of a random sample; the use of a cluster sample; the benefit of a stratified sample; the issues in scale up and the relationship with aggregated indices.

#### *Ensuring delegates sustain their improvement*

The immediate effect of the training is captured via the delegate feedback forms but what is the long term effect? The grand aim of the intervention is to improve the confidence and competence of local government officers. Regular feedback is required to assess the long term gain and this is ongoing.

There have been various attempts to engage employees of the LGO sector in the techniques of quality improvement including quantitative methods, for example Owen and Morgan (2000).

#### ASSESSMENT

Assessment is an emotive issue for many course delegates. Some programmes lend themselves to assessment by delegates making presentations and having a face to face examination. A written assessment at the end of the course can include basic questions on the content of the training and be multiple choice as well as open questions. A certificate of attendance is a minimum level of formality.

It is desirable to hold a review meeting for delegates to discuss their experiences when applying the training in their workplace. These sessions are rarely well taken up, the usual reason being “pressure of work”. Courses including work based practical application ensure the best skills transfer, however, the timing of the course is not always suitable for all the delegates. Anecdotally, about two-thirds of delegates engage well with the programme but only a third are successful in applying the skills immediately; the other third apply them later on.

Assessment of the course and the trainer is carried out by the feedback forms. It is widely expected nowadays that feedback will be requested after any activity. Feedback questionnaires should be carefully constructed. Each question should directly relate to opportunities for improvement. ISRU have experimented with a number of different feedback methods. Most include opinion questions, quantitative questions, open questions and occasionally conjoint analysis. Conjoint analysis asks delegates to consider a number of different training scenarios and in this way, their opinion regarding certain design features of the training can be assessed in context. Arguably, the most important question for the provider is whether the delegate would recommend the training to others.

Everyone would recommend the course to others and thought the course was “interesting”
28 out of 29 thought the course was “relevant to their needs” and they would use the techniques
Some thought the trainer was unable to give sufficient time to each delegate
“Perhaps if we were able to bring some information along to the course and have a practical exercise showing how our data could look, this would be of great benefit.”

Table 1. Feedback from initial course

The results of feedback to initial training are summarized in Table 1. Following this feedback, more use was made of own data and the group size was reduced. The feedback from subsequent courses was very informative, some examples are shown in Table 2.

“The examples brought the subject to life”
“I was surprised to find it extremely interesting and very useful”
“Many thanks for filling the gap – have been looking for such a training course for some time”
“Stats isn’t scary, and this course helps you realize that”
“This is definitely the right course for those who bought “Statistics for the terrified” and found it didn’t help”
“I genuinely learned new ideas and had ideas explained which it has taken me 20ish years to get my head around”
“Perhaps the most noteworthy aspect was the fact that for the second part of the course participants were asked to provide data sets that they would normally be using in their day-to-day jobs which were then worked on as examples using the most appropriate range of statistics that had been demonstrated previously. This meant that there was an immediate way in which the course content could be put to good use rather than being left in the course booklet on the shelf”

Table 2. Feedback from subsequent courses

Further improvements to the training programme will be included as and when they emerge as useful either from delegate feedback, peer review or sea changes in available methods.

## DISCUSSION

Many millions of Euros have been spent and continue to be spent on improving the quantitative skills of the workforce. The problem has been approached from bottom-up by school based projects and top down by addressing members of parliament and instigating investigations

and discussions. The importance of quantitative skills needs to be embedded at all levels for training programmes to have any effect. The well respected BBC has been guilty in the past of broadcasting demotivating swipes at mathematics and indeed anything remotely precise. For example, a caller to a radio phone-in programme started to give the name of his street and his village when the presenter said "Oh please, don't start with that sort of detail, it is as bad as learning mathematics at school". Many respected and extremely clever presenters have been quite happy to declare how useless they were at mathematics in school. The efforts of MEI and many other institutions have gradually changed that attitude and occurrences are becoming rarer.

Pride in mathematics inability has, however, been partially replaced by courageous ignorance. For example, a police officer, who was invited to speak on the BBC radio after winning an award for good service said "From January to June this year, 147 of 1490 complaints were about the courtesy of the police. At this rate 20% of the complaints will be about courtesy by the end of the year and we need to do something about it". As the rate for the first 6 months of the year was 10%, the police officer extrapolated that in twice the time period the rate would be twice as big whereas, it is more likely to stay the same. The democratization of mathematics holds as many dangers for its widespread and correct use as did the previous dismissive attitude shown by some influential people.

The new ideas presented here were focused on improving numerical ability in a particular sector of the workforce. LGOs are a neglected sector as far as workforce are concerned and it is timely to address the shortfall in the competence and confidence of managers who are expected to analyse data in a responsible manner to make policy and planning decisions that affect us all.

In summary, the paper describes new ideas in the following areas:

- the development of a diagnostic tool
- the approach to training and access to people who need it
- the collaboration of several agencies into a multi-disciplinary team
- provision at a level of the work force not usually considered
- staged provision and feedback for continuous improvement

Government is determined to modernize the appreciation of mathematics and to develop a sense of pride in numerical ability. Programmes, such as ours, intend to aid the speedy realization of these aims.

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