From Cooperation to Coordination - The School's Statistics Coordinator

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1. Introduction

This paper is based on a project which ran during 1988 and 1989 at the Centre for Statistical Education, University of Sheffield. The purpose of the project was to produce materials both to train schools' statistics coordinators and for the coordinators themselves to use in school, for their work with pupils and other teachers. These materials are now available from the Centre in a loose-leaf folder (Holmes and Rouncefield, 1989). In this paper, I shall attempt to explain the rationale behind the project and to describe some of the project materials.

2. The need for coordination

The Schools' Council Project (Turner et al., 1981) showed the extent to which statistical ideas were naturally occurring across various subjects in the school curriculum, and the need for schools to take an overall view of what was happening.

In 1982 the Cockcroft Report (Cockcroft, 1982) made several references to the cross-curricular nature of statistics and the need for coordination:

> "Because work in subjects other than mathematics can contribute to the learning and understanding of statistics, efforts should be made to ensure that there is cooperation between all those in a school who make use of statistics in their teaching. Such cooperation could be assisted in secondary schools by the nomination of a member of staff who would identify the use which was made of statistics in the teaching of a variety of subjects and act as coordinator for the teaching of statistics; such a coordinator need not necessarily be a teacher of mathematics." (Paragraph 779)

Statistics is being widely taught in the schools at different levels, in various subjects, and by teachers with varying degrees of experience and statistical expertise. There are special problems in the teaching of statistics. The ideas are difficult, take time to develop, and they need substantial reinforcement through practical experience in a variety of contexts.

With statistics being taught extensively across various subjects, several problems can arise:

(i) The pupil does not experience a coherent picture of statistics at any level of sophistication. Different concepts and techniques may occur in different contexts with no obvious connection. Each pupil needs a coherent experience; it is not enough that the whole picture is balanced if subject option choices upset the balance for individuals.

(ii) Pupils may meet conflicting definitions of the same term in different subject lessons. There does, for example, seem to be considerable confusion amongst teachers of different subjects as to what constitutes a histogram, and a lack of agreement generally as to how axes should be labelled for bar graphs illustrating various types of data (grouped discrete data in particular).

(iii) Important topics may be omitted in the present curriculum. These may include important topics that make up statistical numeracy. The Cockcroft Report (1982) emphasised the need for all pupils to be statistically numerate:

> "Statistical numeracy requires a feel for numbers, an appreciation of appropriate levels of accuracy, the making of sensible estimates, a commonsense approach to the use of data in supporting an argument, the awareness of the variety of interpretation of figures, and a judicious understanding of widely used concepts such as means and percentages. All these are a part of everyday living. Good statistical teaching can encourage pupils to think in these ways." (Paragraph 781)

The important topics may also be areas of application of statistics which do not naturally fall under the heading of any particular school subject. There is a great need to identify and teach the skills required for understanding the statistics which permeates the media; ideas such as cost of living, retail price index, rate of inflation, crime rates, average earnings and so on. References to the use of statistics in industry are also likely to be omitted.

(iv) Few teachers have had formal courses in statistics, and even fewer have had courses in the teaching of statistics, yet many have to use statistics in their teaching; hence there is a lot of insecurity. Most teachers using statistics are aware that they are not experts and feel inadequate in its teaching; they are working outside their area of expertise. This can lead to teachers not seeing important opportunities for using statistics to improve the understanding of their own subject. In some cases it leads to things being taught incorrectly.

(v) Teachers often do not know what their colleagues are doing. This can lead to repetition, omissions, topics being taught out of phase with each other etc. Too much repetition can lead to bored pupils. Sometimes a topic can be in many subjects yet no proper introduction is done since all subjects assume that it is

someone else's responsibility.

(vi) Without coordination it is possible that the harder concepts (but still within the pupils' grasp) may not be reached.

During the project we undertook a survey of the schools belonging to the Centre's "Teacher Network". This showed that there was a considerable mismatch between the statistics being taught in mathematics classes and the skills required of pupils in such subjects as geography, biology, economics and social studies. These subjects require skills of data interpretation and sampling and possibly the design of questionnaires, examination of time series, and an understanding of such topics as the Cost of Living Index. With mathematics teachers often ignoring these topics and teachers in other subject areas often unsure of how to teach the skills involved, pupils often struggle to cope with the project work required of them.

3. The role of the coordinator

The role of the coordinator follows from the nature of the problem as described above.

(i) To coordinate all statistics being taught within the school. This coordination goes both across the curriculum and from year to year.

(ii) To ensure all pupils receive appropriate and relevant statistical education.

(iii) To ensure that appropriate advice is available within the school both on statistics and on teaching statistics.

(iv) To ensure staff are aware of the nature, importance, and usefulness of statistics for their courses and for their pupils.

(v) To draw staff together and to encourage interdepartmental cooperation in the teaching of statistics.

(vi) To encourage staff to develop expertise in statistics and in teaching statistics.

(vii) To keep statistics teaching in school under continual review.

There is also a need for coordination between the stages in the child's education as well as between subjects. The statistics coordinator in the secondary school could form valuable links by visiting local primary schools. Primary school staff may feel worried about undertaking work in statistics and probability and may welcome individual help or group workshops and discussions.

The statistics coordinator may be an enthusiastic but relatively junior teacher who will need to become established in their role and to develop their expertise in statistics and in social and management skills.

For this reason it is useful to view the role of the coordinator as possibly developing in stages or levels. The first aim must be to achieve the cooperation of other members of staff (before any coordination can be achieved).

Coordination can be seen as the culmination of varying degrees of cooperation. It is possible to identify three different levels of cooperation before full coordination. It is possible for individuals to initiate and sustain these levels of cooperation even if they are not an official coordinator. These levels can be thought of as:

Level 1	Making contact
Level 2	Working with individuals
Level 3	Working with groups
Level 4	Coordinating to form a school policy on statistics

These do not need to be seen as sequential. Though clearly the more cooperation that there is naturally within the school the easier it will be to work for full coordination with a statistics coordinator.

3.1 *Level one - making contact*

If you are working at this stage your main aim is to establish goodwill and make yourself known as someone who is interested in working with statistics in any context. You can promote statistics as a worthwhile area of interest in the school and alert pupils and staff to its wide variety of applications. This level is one of elementary, and informal, cross-curricular liaison. You need some basic information such as:

Who teaches statistics in the school?
Who is interested in statistics?
How is the school organised (in departments or faculties etc.)?

The very first step is to prepare yourself. As a teacher, your first responsibility is to the pupils you teach. Whether your main subject is mathematics, geography, biology, economics or some other subject, your interest in and enjoyment of statistics can be communicated first-hand to your pupils. This can be done by making the activities in which your pupils use statistics lively and interesting and preferably based on a practical problem to be solved.

You can keep yourself up-to-date with new ideas in statistics teaching by reading the educational journals which include articles on statistics from time to time. *Teaching Statistics* aims to give teachers help in this specific area. Teachers' associations in most subject areas publish journals which will occasionally include articles on using or teaching statistics. The Centre for Statistical Education produces publications which contain ideas for practical and project work. Looking across a range of texts from different publishers will give a broader view and more ideas.

Unfortunately, the classrooms and corridors in many secondary schools and sixth form colleges are bare and uninteresting. A colourful, informative display will be noticed and appreciated by pupils and staff. It is also a visible demonstration of your interest in statistics - clearly you think statistics is worth spending time on.

3.2 *Level two - working with individuals*

Here you develop and build upon the initial contacts made at the first stage. Work with some colleagues with whom you have a natural affinity. Make it known now that you are willing to help both pupils and teachers with statistical work arising from projects or data collection in any subject area. Build up a collection of reference books and resources and lend them out to other members of staff and keep them informed of in-service courses in statistics. You might suggest joint projects with staff in areas

such as geography, history, biology, PE, or social studies.

The practical data collection work done in other subject areas potentially provides considerable scope for cooperation between teachers in mathematics and statistics and teachers of geography, biology, history, social science, PE, home economics and english (as a minimum set!). Even the results of experiments in physics are amenable to statistical analysis. (Repeated measures for the time taken for swings of a pendulum would be an example here, especially if the angle is altered as part of the experiment. Another example is where the mean of repeated measures is used as a more accurate estimate of the true value.)

It is possible that some colleagues may need help with particular statistical techniques that arise in their subjects. Not all textbooks are careful about matching the level of difficulty of the statistical ideas with the age and ability of the pupils. Often, it appears, they underestimate the difficulty of the concepts being used. Easy ways to teach difficult ideas may have to be developed or some ideas deferred to a later date.

Colleagues organising field trips may need additional staff to supervise pupils. If you volunteer your help you will be able to see first-hand what kind of data are collected, how they are collected, and why. You may then consider the possibility of running a joint field trip or project, so that the data can be used for a statistics project also. For example, you may offer your help at the planning stage with suggestions for drawing up clear data recording sheets, deciding on minimum sample sizes and sampling techniques. Are the correct measurements being obtained in order to investigate the process under consideration? Which graphical techniques can be best used for displaying data? At a higher level significance tests are often used; are these appropriate or would it be more appropriate to make estimates and use confidence intervals? Further points are discussed in the section on Field Trips.

At this level it may be possible to organise team teaching to facilitate the supervision of practical work by groups of pupils both inside and outside of the classroom.

3.3 *Level three - working with groups*

At this stage you may be able to identify a group of teachers interested in statistics and form a working group. This group may meet informally from time to time to discuss cross-curricular projects, problems encountered in project work, or ideas for data collection and so on. It may be possible to run workshops for this group on techniques or topics in statistics. With support from the local authority adviser and head teacher this could become established as an in-service course for staff at that school.

You, or the group, may also be able to establish contact with local industries or community groups. This could lead, for example, to 17-18-year-old students undertaking a quality control project for a small industrial company or 15-16-year-old students conducting a survey of local leisure facilities or of the ease of access for disabled people to buildings around the town.

It is at this stage that you start to need the support of the head teacher and the local authority adviser, and the cooperation of other heads of departments. This becomes essential at the next level. Considerable managerial skills are required and you are unlikely to get this level of cooperation unless you are well established and respected within the school.

3.4 *Level four - coordinating to form a statistics policy within the school*

This is seen as the level of formal cooperation and is for the statistics coordinator. As such it requires the greatest degree of interpersonal skills and recognition by the school authorities. As coordinator you will not only need this support and these personal skills, you will also need to continue your own professional development, be prepared to take initiatives in statistics in your own classroom, and develop a coherent philosophy of statistical education so that you can inform and inspire others. If you, yourself, are not the expert in statistics you need to identify and work closely with those who are expert. All this will give you credibility with the other staff.

Other sections of the project materials deal with the processes involved in gathering the required information so that the pupils' overall experience in statistics can be examined for gaps and repetitions, and the curriculum improved.

Coordination at this level is required if the full benefits are to be obtained. Nevertheless it is unlikely that the original impetus will be maintained unless the teachers involved are interested in and committed to the project. This commitment has its foundations in cooperation at the lower three levels. Such cooperation requires, not replaces, the need for such informal cooperation.

You may find all of the above unattainable in your particular circumstances. Even some steps in cooperation at the lower levels can be very useful for improving the teaching of statistics and its effect on the pupils.

4. Strategies for bringing about change: where do individuals stand?

If change is to be effected, different people need approaching in different ways depending on their personality and position. One way of considering members of staff is to rate them in terms of three key dimensions. The first two of these are power and support. The third is "understanding". Power may derive from authority or influence. A supportive person is one who will help you with your work as coordinator. Figure 1 shows how colleagues may be placed in terms of these factors, with each person's name written in the appropriate quadrant for your own benefit. (It may be as well to keep your diagram private to avoid offence.) "Support" is a measure of how supportive the members of staff are to you, particularly as you try to coordinate the teaching of statistics across the curriculum.

Innovations may sometimes fail due to a lack of understanding of their purpose and nature. Understanding is represented by a circle on the diagram and individuals with an adequate understanding of the proposed changes can be placed inside the circle.

The aim of the coordinator is to bring more people inside the circle of understanding, and more people into the right-hand quadrants.

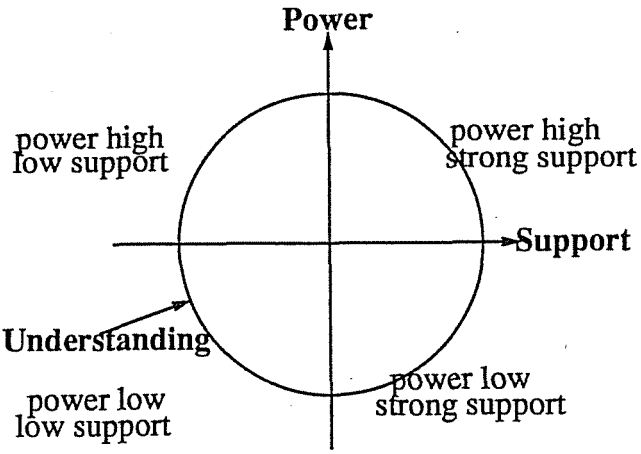

FIGURE 1
(Adapted from the Elliot-Kemp matrix)

According to the positions of colleagues on the diagram, various strategies may be adopted to improve the situation.

(i) *Outside to inside:* The coordinator can bring more people into the circle. To achieve this end you may decide to publish a short report on statistics in the school, raise the issue at staff meetings, initiate a statistics workshop, or use more informal means. This may be a top priority if you prefer informed criticism to rejection of the project through fear or ignorance.

(ii) *Top left to top right:* The coordinator can try to convince people with considerable power that a school policy for statistics is both worthwhile and necessary. Members of staff already placed in this right-hand quadrant can be enlisted as useful advocates.

(iii) *Bottom left to bottom right:* Low status individuals may be converted as supporters by colleagues of similar status who are highly motivated towards the introduction of coordinated statistics teaching. Coercion by high status members of staff is unlikely to be effective.

(iv) *Bottom right to top right:* This fourth method for effecting change may be the most important. In some schools, innovation may be confined to "top down" change where decisions always come from the management team. The problem here is how to help committed teachers in positions of lower power or influence to maximise their potential for achieving change. The emphasis in this situation is on "synergy" building.

Synergy is the extra power and energy created when a number of people cease to function simply as isolated individuals and become a fully functioning group with a sense of identity and mission. In this case, the group in question is the statistics working group or "team". This group must actively seek new members, encourage all

members to share leadership tasks and show that its work is beneficial to the school and its pupils.

5. Summary

In this project an attempt has been made to develop strategies for bringing about cooperation and coordination within the school. The statistics coordinator does not work in a vacuum and must adapt to the situation in which they find themselves.

References

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