USING COLLABORATIVE LEARNING PACKAGES TO TEACH INTRODUCTORY STATISTICS AT THE POST-SECONDARY LEVEL

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Amongst statistical educators there is a wide ranging debate about both the pedagogy and content of the first University level course in Statistics. This paper describes the use of collaborative learning groups as a replacement for the traditional lecture / tutorial mode of teaching in an Introductory Statistics course. The materials used to support this learning approach reflect the wider view of Statistics as a problem solving discipline, with a heavy emphasis on real situations and the role that statistical thinking plays in them. The importance of structuring the learning environment to overcome many of the common problems with the use of groupwork is discussed.

INTRODUCTION

In this paper I will describe an approach to teaching an introductory Statistics course through the use of collaborative learning groups. In next section I briefly outline the relevant aspects of the context in which this change to teaching practice operates. A detailed discussion of the approach, and the principles which underlie it, is given in the section entitled “The approach and the principles which underlie it”. In “The packages” section I describe the materials and tasks given to the students to work on and in penultimate section I outline the process used to aid the development of group skills and the role that assessment tasks play in facilitating the effective use of small groups. I conclude in the last section with some student responses to the changed practice.

THE CONTEXT OF THE CHANGE

The context for this change in the teaching of introductory Statistics is a course which is offered to a small group of Mathematics and Computer Science students in the first year, first semester of their enrolment at the University of South Australia. The course is typically 4 hours of class time per week for a 13 week semester. The class size of approximately 35 gives the unfortunately unique opportunity to experiment with quite radical departures to traditional teaching methods which are not so easily undertaken with much larger classes, particularly at the undergraduate level.

THE APPROACH AND THE PRINCIPLES WHICH UNDERLIE IT

The approach described here is built on a number of principles which summarise recent educational research into the design of effective learning environments. John Biggs(1989) characterised effective learning environments as containing ‘one or more of the following

- an appropriate motivational context
- a high degree of learner activity
- interaction with others, both peers and teachers
- a well structured knowledge base’ (page 17)

In order to provide an appropriate motivational context and a well structured knowledge base, materials and problem situations have been taken from a range of local research and industrial settings and used to construct packages which introduce basic skills and require students to apply them critically as described in more detail in section 3. In order to promote learner activity and opportunities for richer interaction with their peers and with teaching staff, the students spend approximately 8 of the 13 weeks of the course in groups of 4 -5 studying packages of materials and completing a range of group tasks. During the remaining weeks, lectures and tutorials / computer practical sessions are given to provide an overview of the material in the packages, to draw together issues raised during the group work or to cover additional topics which are not treated explicitly by the packages such as regression modelling. The students appreciate the variety that the combination of these two forms of teaching provide.

Whilst the groups are working on these packages there is no formal class contact time. During a typical week students will spend time on their own studying the material set for that week. They then meet with their group at times during the week of their own choosing. At this meeting they go through their work and check their own understanding and make sure that everyone in the group has understood what has been asked of them.

Once a week the group meets with the subject lecturer for approximately an hour. During this time the group is asked to go over their work and any misconceptions or unresolved problems are clarified. Some assessment tasks are occasionally scheduled for these meetings. The lecturer also uses the opportunity to get the group to reflect on its performance as a group and to resolve any difficulties that it might be having or to seek ways of being more effective. Due to the small sizes of the groups, this meeting time provides the opportunity for students to obtain rich feedback on their work.

THE PACKAGES

At the moment there are two major packages of material. The first of these is undertaken during weeks 2 -6 and covers material on problem solving, measurement and variation. The second package is completed during weeks 8 - 11 and incorporates material on the statistical analysis of experimental data. The packages are designed to have three levels. The students begin by learning a range of basic skills, primarily on their own with some group and teacher support and feedback. These skills are then applied to problems which require them to combine several skills and to think critically about the application of the methods they are considering and the assumptions that are involved. This second level plays an important role in the linking together of their knowledge. The third level is a group task which asks them to build on what they have learnt in the package to find out something more advanced. The major goals of this part of the package are to build the student's confidence and skill at learning new things for themselves and to expose them to more open ended problems which lend themselves to the effective use of their groups.

The first package concentrates on general statistical aspects of problem solving, measurement, experimental design and variation. The problem solving process outlined by Woods (1994) has been adopted as the core problem solving framework for the course. Students are introduced to the stages of engaging, defining the stated problem, exploring or creating an internal image, planning a solution, carrying out the plan and looking back. To connect this general model with their study of statistics, the students are given a range of examples of descriptions of problem solving activities from local organisations and the scientific literature and are asked to explore the statistical processes that are used eg. measurement, sampling and study design and the role that they play in exploring problem situations and developing and evaluating solutions. One of the first exercises that they are given to work on as a group is to design a process for providing information to the Dean of the Faculty on how satisfied the students enrolled at the University are with their experience.

The basic skills component of the first package focuses on the principles of effective measurement and study design, the graphical and numerical analysis of data using Minitab and the use of the Normal probability model. These basic skills are

integrated through the use of a number of measurement and sampling problems from local industry such as the measurement of weights of fruit bars from a production line and the reliability of various measures of body posture and muscle performance from sports science and physiotherapy. The students are introduced to the ideas of variation within the context of Statistical Process Control. A number of examples from local industries are used including the monitoring of oxidation levels at the local brewery and the levels of various components of the sewerage at the local water treatment plant. In the third level stage of the package students are asked to develop their understanding of the theory behind the construction of limits for the mean and range charts through simulation. They are also required to apply their knowledge to the development of a group data collection project, which progresses through the semester.

The second package is an introduction to the key ideas and methods of the statistical analysis of experimental data. In the first level of the package they study a variety of tests and learn their individual details. In the second part of the package they need to select appropriate procedures and to look critically at the assumptions underlying the tests. These problems are generally selected from recent research projects and consultancies. In the third level of the package the groups are given a set of data and asked to present the analysis. Whilst the selection of an appropriate analysis will have been covered in the package the details of the method of analysis will not have been and so the students are responsible for finding out how to do the analysis, how to do it in Minitab, what assumptions to check etc and are required to give a class presentation of their results. As an example I have used analysis of variance as a technique for this task in the past.

USING GROUPS EFFECTIVELY: DEVELOPING GROUP SKILLS AND THE ROLE OF ASSESSMENT

Using collaborative learning groups effectively is a difficult task. Assigning students to a group and giving them a task to do is unlikely to be very effective. In a summary of their research into collaborative learning (in Davidson,1990) David and Roger Johnson list the following five principles for effective learning groups

- Teachers must structure positive interdependence within the group
- Students must engage in face to face interaction

- Teachers must ensure individual student accountability for their own performance and the learning of their peers
- Students must learn and practice interpersonal and group related skills
- Teachers must ensure that groups regularly reflect on the performance of the groups.

The individual and group requirements of the learning tasks, as explained previously, and the assessment scheme are very critical to the successful use of collaborative learning groups in this class. The course is assessed using a variety of tasks which cover the range of statistical objectives of the course as well as the extent to which the students have been able to work effectively in their group. A balance is sought between the assessment of group and individual performance to maintain a sense of both individual accountability and interdependence with other members of the group. Individual contributions to the assessment come through a Minitab test on the work of the first package worth 10%, an individual presentation of the analysis of a set of data in the second package worth 10% and a combined Minitab and theory final exam worth 40% of the final grade. The groups are assessed on their project (15%), a group presentation of the analysis of a set of data in the second package (10%) and on their performance as a group over the semester (15%).

In order to develop their ability to work in groups, students are shown a video produced from groups working in the subject from a previous year. The video emphasises the need to get to know the other members of the group, to develop trust within the group, to understand the normal stages that groups usually go through, to appreciate the need for people to take different roles within the group for it to function and, most importantly, to encourage the group to examine the processes by which the group is performing its task to ensure that it is functioning effectively. A number of exercises are used to get the students thinking about how they will develop an effective work group and what their contribution will be. At the weekly meetings with the lecturer there is some probing of how the group is working and what might be done to help it function better, thus allowing for group processing and reflection.

STUDENT REACTION TO THE SUBJECT

The approach described in this paper, whilst having been developed over three years, is still very much in its formative stage. Evaluations have been done using student

interviews. The general reaction is favourable with some concerns about the initial introduction to the use of a quite different method of learning. Students have found the course less stressful and more enjoyable than their other courses. They enjoy seeing the practical application of Statistics in local contexts that they can identify with. They comment often on the importance of the social aspects of getting to know the other students in their courses as being of significant benefit. Most of the students comment that they get value from the small group meetings with each other and the lecturer, they find that they get much richer feedback on their work. In response to their concern about getting used to the idea of learning in a different way I have produced a video of the experiences of students in a previous class as described previously. This helps them to develop an idea of what it is going to be like and what they have to do to be successful in this mode.

REFERENCES

Biggs, J. B. (1989) Approaches to the Enhancement of Tertiary Teaching, *Higher education Research and development, 8(1),* 7-25.

Davidson, N. (1990). *Cooperative Learning in Mathematics*. Addison Wesley, New York.

Woods, D. R. (1994). *Problem-based learning: How to gain the most from PBL*. W.L. Griffin, Hamilton, ON.