

PEDAGOGIC ISSUES REQUIRED FOR SUCCESSFUL STATISTICAL PROJECT COMPETITIONS ®

Susan Starkings
South Bank University
United Kingdom

There are many ways of teaching students to use statistics and all of these methods have their own relative advantages and disadvantages. The use of projects to enhance learning is one of the most effective methods to use. Students during the project duration need appropriate support for the maximum benefit, from the project, to be obtained. Many countries have successfully implemented statistical project work into their education programmes. The experience gained by students and the teachers, involved with the projects, has been of enormous benefit to the statistical education in these countries. Examples of how statistical projects that have been implemented are to be elucidated. Statistics lends itself to the practical aspects of life and enables students to come into contact with real data, often for the first time in their studies. This data can be usefully employed to engage the students in meaningful debate about, for example, the environment and what statistics should be used to emphasise the salient points being made. Project work brings together many facets of education, statistics being one of them.

INTRODUCTION

Statistics is essentially a practical subject and one of the main advantages of using projects is that, for many students it is the first time that they are exposed to real data. The students then have to decide what data to collect, how to attain this data and what to do with this data. A project puts statistics into context and allows students to connect various pieces of knowledge together in a practical way. National competitions have been implemented in many countries and funded by various sources. Usually for each country there is some form of prize awarded as a reward for the best piece of work submitted for the competition. The competitions allow students from across each country to compete with each other for a national prize. In some cases the competitions have been international and hence students work is from many educational establishments from around the globe. The prize provides an incentive for the students to participate. There are many similarities on how countries run the competitions and the main educational aims are that the students see and use statistics in a practical environment.

Any project involves a student, or group of students, working under the guidance and direction of the teacher. A project involves planning and developing a schedule of study with outcomes to be achieved over a period of time. Implicit in the project is the deeper understanding of the subject and the bringing together of many statistical techniques. The students are not required to only produce a single outcome, but are required to link multiple, often distant related, prior learning tasks. The experience gained by the students and the teachers, involved with the projects, has been of enormous benefit to the statistical education in those countries that have implemented them into their respective curriculum.

PLANNING

Doing a statistical project can be both enjoyable and worthwhile, but if the results are to be meaningful and useful great care must be taken at the planning stage. Some students and teachers learn by the mistakes they make, however, by careful consideration of the points/questions listed below these can be kept to a minimum.

Questions to be addressed before starting a project:

1. What exactly are you trying to find out?
2. Who or what do you want to find out?
3. What sort of information will you collect?
4. How shall you collect your data?
5. What should you include on your data collection sheet or questionnaire?
6. How long do you have to complete the project?

7. How should you choose your sample?
8. What resources do you have?
9. How accurate must the results be?
10. How big a sample should you choose?
11. How will you collect together the answers?
12. How will you present the findings?

Time spent planning will be time well spent and can save time in the long run. A well-planned project is beneficial to both students and teachers alike and will certainly show up in the finished production.

EXAMPLES OF STATISTICAL PROJECTS

The first Statistical Project Competition in Hong Kong for secondary schools was introduced in 1986. This was a major step forward in getting students to participate in using statistics in a practical way. Hong Kong's curriculum is oriented towards examination success and hence topics of interest, which do not have a direct bearing on examinations, is not always readily received in the classroom environment. Educationally one could argue that carrying out some practical statistics would hopefully enhance the students learning and understanding of the subject matter. Shen (1996) when writing about the secondary education in Hong Kong stated that "Statistical Projects with emphasis on data analysis are even rarer. It was seldom, if not never, seen until the Hong Kong Statistical Society launched the first Statistical Project Competition." p. 31.

To enter the competition a group of students have to carefully consider and plan an area of statistical interest that they wish to peruse. The students then collect any relevant compiled data that is required, perform relevant statistical analysis that is needed to answer the area of interest chosen, provide justification for any hypothesis or arguments stated and a sound and well justified conclusion should be included. The findings are then compiled into a written report which not only includes the conclusions reached but any statistical diagrams, hypotheses tested, description of why and what data was collected and any relevant information the group think is appropriate to enclose in the report. The regulations of the competition do not allow students to collect raw data.

Shen (1996) interviewed teachers and students who had participated in the competitions, in Hong Kong. Her findings were that for many students it was the first time that they started to understand or grasp the significance of what they had learned in the statistics classes. The students had to make decisions on what analysis to perform which is very different to being told in an examination to perform a hypothesis test to see if there is any difference in, for example, the test results for class A and class B. The students have to decide if this is valid or required for their chosen area of interest. This decision making process helps the students to identify when to use a particular technique and what the results mean. Statistics is part of the mathematics curriculum and whereas, in mathematics where there are formal techniques to use statistics mirrors real life problems where there is often no right answer. The students have to fully justify the arguments they put forward and use statistics to support their claim.

The competition, in this country, provides the students with the opportunity to use statistics in a practical environment. Shen (1998) stated "that statistics began to get its identity and teachers found the project competition useful in arousing the student's interests in studying statistics" (p. 1162).

Habibullah (1992) stated that "It is imperative that practical projects involving the collection and analysis of real data be made an integral part of the Statistics courses at the FA/FSc level and BA/BSc levels" (p. 16). The government of Pakistan introduced small scale projects into the examination assessment for the first time during the academic year of 1992-93. At Kinnaird College, Lahore, Pakistan a considerable amount of progress has been made over the last decade to try and bring into statistics a practical element. This has partly been achieved by the Inter Collegiate Statistical Competition, which was held for the first time in 1990 for all colleges/schools in Pakistan and held annually ever since. The Department of Statistics at Kinnaird College for Women, Lahore launched in 1997 the Data Analysis Talent Award ('DATA') for the worldwide community of students' aged 16-20. This extremely ambitious competition, which was not successful during 1997 was re-launched and entries from 2 countries

were submitted. It is aimed to run this international competition again perhaps every two years in the future. The organiser is busy doing her PhD at the moment and due to time restrictions this competition is on hold. The rules of the competition can be summarised as follows:

1. Students may participate in this competition either individually or in the form of teams of 2 to 6 students under the supervision or guidance of a teacher.
2. Each student/team should carry out a statistical project as follows:
 - a) Choose the topic of their study.
 - b) Decide the specific objectives of their study.
 - c) Decide the source of their data (i.e. the geographical area/institution(s)/socio- economic category of the people from whom the data are going to be collected). The study should be based on real, freshly collected/primary/unpublished data.
 - d) Devise a methodology for data-collection.
 - e) Analyse the collected data and draw conclusions.
 - f) The study should be presented on a set of 2-4 posters.
 - g) A report of the project in the form of a 5 to 10 minutes video recording or audio recording or in the form of a written paper/article. (In previous years only the posters were required).

It is hoped that interest will be stimulated once again in this type of work and that more countries will participate. It is open to debate as to whether other countries should be involved with this initiative. Projects do rely on government legislation, organisations interested in supporting these or individuals prepared to set these in motion for this method of teaching statistics to be successful.

A variation on the project competition in Pakistan took place during 1999 when the students from Kinnaird College undertook a survey of problems experienced by female nurses during their working day. Presentation of the findings was given to representatives from Kinnaird College, the hospital authority and experts in the area of statistics. Prizes and certificates of achievement were given out. According to Habibullah (2000, p 77)

The nurses' day at Kinnaird College was one of the numerous programs that have been organised by the department of statistics at Kinnaird College during the past fifteen years for the promotion of the subject in the country. Such an educational activity not only enhances the students' ability to understand and communicate basic statistical concepts, it serves to disseminate information on a topic of social interest. Combining information with entertainment, such a program provides an effective forum for promoting interests, and for attracting students toward a discipline that is generally considered to be dull and dry subject.

Problems raised by teachers in Pakistan are that students have problems defining and applying simple concepts. The text books used are not suitable for practical statistics of the type needed to help students with project work. Examples of positive outcomes are that the competition is both educational and interesting, it brings practical confidence in participants and the exhibition, of the competition entries, is a very good way to show new students who wish to participate in the next competition.

In the United Kingdom statistical projects and competitions have been around for many years. The Royal Statistical Society(RSS) has provided sponsorship for projects from school level up to graduate level. The topic is invariably chosen by the student or group of students, data can be collected from published sources or the student(s) themselves. The analysis of the data is decided by the student(s) with guidance given by their teacher(s). A formal report including description of the project, methods used, tabular and graphical presentations and conclusions reached are produced for the competition entry. It is unusual to have a video or audio recording of the student(s) work. A committee of statistical experts and statistical educationalists then decides on the winner(s) of the competition. The project competitions are divided up into categories usually by various age ranges and prizes awarded to each category.

Industry also plays a part in supporting statistics projects for students at university. The Association of Statistics Lecturers in Universities (ASLU) awards 2 annual prizes for undergraduate projects in statistics. In 2001, Amgen, an industrial company, awarded a further

prize for a BSc undergraduate project in applied statistics and a new prize for the best MSc postgraduate project in medical statistics. The two Amgen prizes will also be administered by ASLU in conjunction with their existing prizes.

There will be a cash prize for the student(s) and an equivalent cash prize for the supervisor. If the project is done in a group then the prize will be split equally amongst them. The BSc prize will be £100 each for the student and the supervisor and the MSc prize will be £150 each for the student and the supervisor. Rules of the Competition are:

- a) The student must be registered on a full or part time course in a mathematics or statistics department at a recognized University or a higher education establishment within the UK.
- b) Each University department may submit one BSc project and one MSc project.
- c) The project must be the work of the student and it must be written in English.
- d) The BSc project may be on any aspect of applied statistics, although preference may be given to projects with medical / human biological applications.
- e) The MSc project should cover any aspect of medical statistics or clinical trials.
- f) A panel of (independent) statisticians will select the winning project(s). Their decision will be final and binding.
- g) The projects are to be submitted by the dates specified and presentations of prizes are approximately 3 months after submission date.

Teachers have become familiar with this type of work over the years; however, the number of entries to the competitions has decreased over the years. One reason for this is the emphasis on National Testing and Assessment has taken priority over these competitions. However, statistical projects are now a formal assessed part of the examination assessment in the United Kingdom. In 2002 the General Certificate in Secondary Education (GCSE) for mathematics now includes a compulsory statistics project which is worth ten percent of the overall marks. The emphasis on practical work has posed teachers with many problems. Finding suitable problems for practical work to be carried out and how to incorporate these practicals into the classroom environment is the most frequent worry. The RSS has carried out a number of workshop days to help teachers and pupils with the statistics projects. For the GCSE project there are no prizes awarded unless you count the passing of the examination component.

SKILLS AND TECHNIQUES

“Project work is a method of allowing students to make to use what they have learned in statistics classes in a practical context. It is this practical application of projects that make them such a useful part of the learning process” (Starkings, 1997, p.139). Holmes (1997) makes the distinction between practicals and projects as “A practical introduces the topic or reinforces some particular theory; a project links a number of topics. ...A project also requires a more substantial report to be written, while practicals are more easy to control than projects but do not develop global skills” (p. 157).

The incorporation of project work into statistics lessons has demonstrated to both teachers and students alike that this is a demanding technique. Students need to link topics and techniques they have learned which are much more demanding than learning one fact after another. Students have to be able to transfer skills from statistics to say projects in other areas such as geography and science. Familiarisation of a great deal of information plays a vital role in these projects. Decisions have to be made as to what techniques are applicable to use. Careful planning, by teachers, of lessons and syllabus areas to be covered have to take place before commencing the projects. Teaching often continues during the project lifetime and the teacher should set aside time for the students to complete their projects. The teacher's role is one of facilitator of learning as opposed to instructor. The teacher guides the student through the project giving help and assistance when required. In this context the teacher has to be familiar with a variety of statistical techniques and new teachers may find this a difficult concept to deal with. The teacher's role is multi-tasked they have to check that the students are engaged in meaningful activities, motivate students as and when required, carefully plan the lessons allowing time for students to do the project work and grade/mark the students work according to the assessment criteria. For a project to be successfully integrated into the curriculum the following should be taken into account: “It is

important that both teachers and students know precisely what is involved in doing project work” (Starkings, 1997, p. 140).

DISCUSSION

The importance of project work in the curriculum is manifold; however, the use of projects for competitions is no panacea for solving all problems. The competition can be a motivating factor to aid the learning process but care must be taken so that the project does not become the only important topic the student is working on. Students need to beware that other subject lessons may still be taking place and award due time to these lessons as well as the project. For a project to be successful, teachers should ascertain that students are able to solve novel problems, devise an approach to investigate the problem using appropriate techniques, keep details of the progress of the students, communicate results to students as and when required and be readily able to discuss the results with the respective students. If students are carefully guided during the projects duration then the integration of the statistics techniques can be readily assimilated and used when required.

The aim of this paper was threefold namely (1) to identify examples of good practice that have been used in other countries (2) to present the pedagogic issues that enhance the learning of statistics and (3) to review and assess the importance of project work for statistical education within educational establishments.

Education is the main concern of the teachers and one of the main aims is for the student to become an autonomous learner. Project work provides a medium whereby the student can be helped to develop this autonomy. The use of project work to promote self-directed learning is a worthwhile activity in itself. Many countries have successfully integrated the project competition into their respective curriculum. There are similarities between these countries competitions such as a prize is awarded, the project is presented in a similar format and the educational outcomes are identical i.e. that the student(s) use statistics in a practical environment to enhance their learning and understanding of statistics.

REFERENCES

- Habibullah, S.N. (2000). Conduct and Presentation of a Statistical Survey: An effective way of increasing the popularity of a ‘Dry’ subject. In Susan Starkings (Ed.), *Papers on statistical education* (pp 71-78). Paper Presented at ICME-9: Tokyo, Japan.
- Habibullah, S.N. (1992). Statistical education in developing countries: The Pakistani scene. In L. Piereira-Mendoza (Ed.), *Proceedings of the ISI Round Table Conference*. Lennoxville, Canada.
- Holmes, P. (1997). Assessing Project Work. In I. Gal and J. B. Garfield (Eds.), *The assessment challenge in statistical education* (p 156). IOS Press: Netherlands.
- Shen, S.M. (1998). Mistakes and difficulties encountered by students participating in a statistical project competition: The trend of change. In L. Piereira-Mendoza (Ed.), *Proceeding of the 5th International Conference on Teaching Statistics* (pp 1157-1163) Vol 3, Singapore.
- Shen, S.M. (1996). Data Analysis in Secondary School Education in Hong Kong: Curriculum, Examination and Projects. In B. Phillips (Ed.), *Papers on statistical education* (p 27-33). Presented at ICME-8: Seville, Spain.
- Starkings, S. A. (1997). Assessing students projects. In I. Gal and J. B. Garfield (Ed.), *The assessment challenge in statistical education* (p. 139). IOS Press: Netherlands.