# COOPERATIVE WORK IN STATISTICS PROJECTS FOR VERY BUSY STUDENTS

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*Some academic settings are more favorable to cooperative work in than others. We show how group project work can be used where students are very busy with non-academic pursuits.*

## INTRODUCTION

If you listen to students' reflecting on their student years, you are struck by how the content of the learning takes low priority. Probably first recalled are the personalities of their teachers' and after that, the experiences that they went through during their education: "She cheerfully made us write five papers . . . ' is the kind of thing you hear. That it is experiences that are remembered suggests that we think of how we can structure life for students so that they have experiences we think are fruitful. It is common now to write about students' learning in terms of student learning outcomes (or SLOs). To think in terms of desirable experiences for students is not inconsistent with thinking in terms of SLOs, but starts to focus on the means by which the SLOs may be attained.

One of the educational experiences that we generally think is fruitful, and a worthy goal is the experience of working together with a small group of people putting together and writing a report based upon research: in short, a writing project. It is an authentic experience in the sense that it is in accord with what people do outside the student world. The task certainly includes the application of the material being learnt in the statistic module but, very importantly, putting into language the results of statistical work. Moreover, the project may also involve cooperative work if it is specified that the work be done in a group.

## SCENARIOS FOR MEANINGFUL COOPERTIVE WORK

Cooperative writing projects are a good thing to include in the introductory statistics course; but are they feasible in all educational settings? In many parts of the world higher education is fairly specialized, and the typical program of study is well integrated. People can plan an educational program (or a "course of study") so that there is a statistics module that is coordinated with the other material that is being studied. As an example, think of a degree program in environmental management. A single research project involving data collection, statistical analysis and a meaningful written report could easily be integrated into the entire program of studies, and meet several goals at once.

Students in higher education are typically away from their home towns and families in residences close to the academic institution and often are either fully supported by their families or by government grants. In this scenario, it is relatively easy for students to meet together to work on a group project. They are close together, and they have the time, if they take it.

These are scenarios that are congenial to cooperative work. Contrast these with the situation in North American community colleges. Community colleges (or two year colleges) in America are designed to offer opportunity for higher education to students who may otherwise have missed their chance for higher education. Typically, the fees are low, and the entrance requirement non-selective.

Something like 75% or 80% of community college students (at least in San Mateo, California) have part-time (or sometimes full time) jobs alongside their educational pursuits. It is typical also for students to have family responsibilities because they live at home: they are called upon to look after their younger siblings or their grandparents, for example. All of these features of student life militate against meaningful group work: they do by no means make it impossible, but they work against it.

Moreover, the structure of much of North American higher education gives very little intellectual coherence in the first two or three years of a degree program, "Course units" are unrelated to each other, and it is left to the students own devices to see any kind of pattern in what is being learned.

To include the experience of working together on a research project that results in a written report would seem to be a challenge. Yet, if carefully planned, the challenge can be met, and students can collect analyze and write about data – working together with others. The rest of this paper describes such projects and why we think they work even in our unfavorable setting.

## INGREDIENTS FOR A MEANINGFUL COOPERATIVE RESEARCH PROJECT

"Projects" in statistics education can be small or big, using masses of data or a small data set. (See, for example, the projects described in Millard and Turner 2004). The project described here is fairly ambitious and incorporates most of the descriptive statistics part of the usual "course." As in a cooking recipe, we start with the ingredients.

The ingredients for a meaningful cooperative statistical project in our view are first: data, better if freshly collected. A second ingredient is an overall comparative objective that can be broken down into statistical analyses that have a connection with the material being presented in the statistics module, Third, we need to have the capability of handling a substantial amount of data, which usually means some kind of statistical software. Fourth, we need the requirement that the results be written up in a report.

With some students it may be possible to say: "Find some data that can be analyzed using what you have learnt, analyze these data and write up your findings in a report." If statistics is being taught in the context of other studies where the application to data being collected is fairly obvious (one thinks of studies in ecology) then perhaps students would be able to have students' such a report. Our experience is that many students, left to their own devices will either collect flawed data or spend a huge amount of time collecting data. The data described in the project here are fresh in the sense that the data is always changing, but the data are easily collected.

### *Data*

The project described uses as data advertisements for used cars shown online or in newspapers. The data typically include the price of the car being asked, the model year of the car (so that the age of the car can be estimated), and the make and model of the car. Other variables available include the color of the car, the body style, the distance driven, the type of engine (engine capacity, whether diesel or petrol).

If data are found in newspapers, then they have to be typed in by the students into a spreadsheet or statistical software package. When the author first started using this project with students, all of the data were collected in this way. Recently, data collection in America has got very much easier because the data on www.cars.com can be read into Excel or into a software package such as Fathom if the data are saved as an "html source" file first. The author has found that the data are not as conveniently organized on-line in other countries, such as the UK or Brazil.

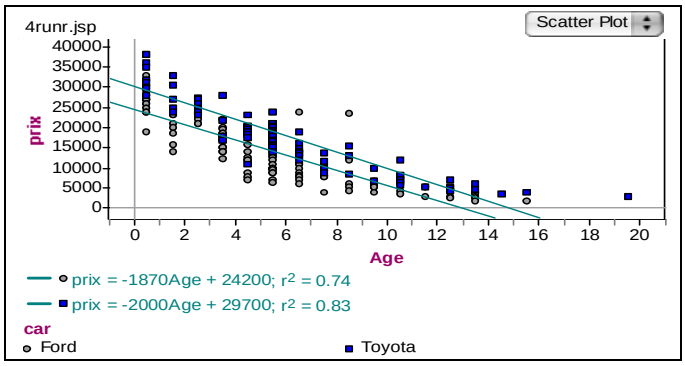
### *Analysis and Software*

Students are set the task of comparing the markets for two competing makes of vehicles in the same place, or comparing the markets for the same make of vehicle in two places far enough apart that they can be considered separate markets. They could as well compare the markets for cars sold online with cars sold in newspapers. They are to use all of the techniques and knowledge available to them at that point in the fifteen-week module. Typically the project is assigned at about the time students are studying correlation and regression where these topics are introduced fairly early, as with Moore's texts (e.g. Moore 2004).

The instructions given to students are deliberately left somewhat vague as to exactly which analyses will be appropriate, and especially so toward the beginning of the project, which is assigned several weeks ahead of the due date for the final report.

Here is an example of the use of regression analysis to explore the relationship between the price asked for the car and the age of the car.

These students compared the markets for Ford Explorer and Toyota 4Runner, competing SUV type vehicles that have been on the market for some time.




*Writing*

Part of the direction not left vague is that the results have to be written up as a paper. That students have the experience of writing about their findings reinforces the importance of the meaning of statistical analyses, and not just the calculation of measures.. The same objective is supported elsewhere in the teaching module with assignments and in assessment activities. The students who compared the Fords and Toyotas wrote this about their analysis:

> In this graph Age is our explanatory variable and prix is our response variable. In this graph we see that both slopes are almost the same with Toyota's slope -2000 and Ford's slope at -1870. By analyzing the graph we can see that as Toyotas and Fords get older their price depreciate almost at the same rate. We can actually calculate each cars individual relative loss by taking the slope and dividing [by] the y-intercept for each car. For example we took Toyota's slope of -2000 and dividing that by its y-intercept of 29700 which equals -6%. For every year that Toyota gets old its price drops by an average of 6%.

For most students writing a paper while learning mathematics is a new experience. At the same time that the initial directions are deliberately vague we attempt to give as much help as we can to students along the way. The students who wrote the analysis shown above probably would not have done the additional analysis on the relative loss had they not initiated a discussion about their findings with their instructor.

Several opportunities are given for students to submit drafts and partial drafts for review. Given students propensity to procrastinate, as well as the academic and work loads community college students typically carry, multiple "due dates" appear to be an essential ingredient for the success of the cooperative project. At the same time that students are working on this material, hints are given as to where they may possibly founder.

WHAT MAKES IT WORK?

Given that the community college is a relatively unfavorable setting for this kind of cooperative project, it is well to think about what makes it work. Here are three conclusions.

*Cooperative Work is Used as an Integral Part of the Teaching Strategy*

The coursework was built around the Rossman, Chance, and Lock (2001) text. As a result students were accustomed to working together in groups of two or three and sometimes four. At the time that the "Car Project" was started students had had several weeks of experience working with at least one other person and had learnt to work with at least one other person.

It is interesting that most of the two and three person groups working on the projects are exactly the same groups that worked together every day. For the most part students do not know the other students doing statistics before they meet them at the beginning of term, although there are exceptions. That cooperative work is used everyday is probably one of the most important reasons that it works with the project.

*Analysis Can Be Done Anywhere*

Every student bought as a part of the text package, a student copy of the *Fathom*™ (Key Curriculum Press, 2005) software, and this software is also used as a part of the normal teaching. The most important aspect of having the software was the flexibility in time allocation that it allowed the students. Prime academic time for some community college students is late in the night, after they have worked a job, and when the other people in their house are sleeping. They did not have to be "on campus" to do the work. This flexibility meant that the groups could divide the work of analysis between the members, and the members were able to do the work when they had time. Since the analysis and the writing were typically done on computers, students are also able to communicate with each other electronically. Other readily accessible software could also be used, but it is important that every student in each group have the software.

*Data Are Easily Collected and Accessible to Students' Understanding*

The fact that the data are easily collected tends to get students going on the project. Otherwise, their natural fear of starting takes over. Most students are familiar with markets for cars even if they have themselves not bought one. They may certainly need some advice about the choice of car or place of analysis, but they generally understand the basic idea. The instructors do need to be prepared to answer questions that arise in the course of the project.

Not all groups need the structure of the "Used Car Project" to proceed: some groups are able to strike out on their own with a project of their own creation, generally with interesting results. However, we have hoped to show by this example that given proper planning and facilities a cooperative statistics project can be used in statistics education even in an unfavorable academic environment.

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