

From Gal, I. & Garfield, J. B. (editors). The Assessment Challenge in Statistics Education. IOS Press, 1997 (on behalf of the ISI). Pages 139-151. ISBN 90 5199 333 1. Copyright holder: International Statistical Institute. Permission granted by ISI to the IASE to make the chapters from this book freely available on the Internet. The References section is a separate chapter and is available on the Internet at <http://www.stat.auckland.ac.nz/~iase/publications/assessbkref>.

11. Assessing Student Projects

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Purpose

The main purpose of this chapter is to offer practical advice to teachers who want to use projects in their courses. In this chapter some examples of projects are given, two assessment models are explained, and teachers' experiences are described. The project models and examples described have been used with students of 14 to 18 years of age, but can be adapted for younger or older students as well

INTRODUCTION

Assessment plays a major role in education, possibly more so now than ever before. A key role of assessment is the diagnostic process—by establishing what students have learned, it is possible to plan what students need to learn in the future. Project work is a method of allowing students 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.

Although project work may look easy, a brief introduction with this way of working will show how demanding it really is for both teachers and students. Students must make connections between one piece of learning with another. They have to transfer the skills acquired in statistics to other areas such as science and geography, and vice-versa. They have to familiarise themselves with a wide range of information. This is much more demanding than learning one isolated fact after another. Integrated work of this kind is often the best preparation for higher education and future employment.

Many forms of assessment, such as assignments and learning activities, are written by teachers for students, i.e., teachers do the thinking and students act on their instructions. Educational psychologists have shown that learning is not like walking in a straight line or climbing a ladder. We do not all learn one thing, then another, then another, in the same order. It is more accurate to compare a student's learning to doing a 3D jig-saw puzzle or making a complicated model rather than climbing a ladder. We put in a couple of pieces, then we may do another section altogether. Sometimes we make a connection we had not seen previously, and occasionally we link two sections together that had not been apparent before. Project work allows students to connect various pieces of knowledge together that suits a solution to a chosen problem.

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This chapter examines issues that arise in the process of designing, doing, and reporting a project. These issues relate both to the students doing the project as well as to the teacher (who serves as both facilitator and assessor). The chapter is divided into seven sections:

1. Starting a project and initial advice
2. Staged assessment
3. Teaching structure during project completion
4. Presentations of projects
5. Teachers' experiences
6. Feedback
7. Implications

STARTING A PROJECT: INITIAL ADVICE

The project

Any project involves a student, or group of students, working under the guidance and direction of a teacher. A project involves planning and developing a schedule of study and outcomes to be achieved over a period of time usually longer than that of an individual assignment. Implicit in the project are educational ideas of deep learning as opposed to surface learning. The students are not required to only produce a single outcome, but are required to link multiple, and often distantly related, prior learning tasks. The role of the teacher throughout the project is one of a facilitator of each student's learning strategy.

It is important that both teachers and students know precisely what is involved in doing project work. The students should be familiar with the assessment structure that will be used by the teacher to assess and grade their project. The next section gives some assessment models that could be used for this process. The students should be given a copy of the model marking scheme (or grading guidelines or scoring rubric) that is chosen to formally evaluate their project.

Individual or group projects

Project work can be carried out individually or in groups. The formation of groups can be carried out in one of two ways: either students form their own group or the teacher identifies the group membership. Both of these methods have their own merits and drawbacks. Students who form their own groups tend to choose friends with similar backgrounds and objectives. This may detract from the rich learning experience to be gained by groups formed by students with different approaches to learning. Kelly (1978) advocates that for students the "furthering [of] their social and personal education" is an essential feature of group project work.

Teachers can form groups in a variety of ways. It could be done randomly by allocating a number to each student and selecting these numbers from a hat or by using random number tables to select groups. If this method is adapted some useful statistics can be discussed and elucidated during the selection process. One of the most useful methods used is to compose groups by individual student ability. In order to use this technique this method obviously assumes that the teacher knows his/her students. Teachers who previously used this method recommend that the group contain a mixed ability range; otherwise one may well find that a high flier group or a very weak group often materialises. (Weak groups present problems when—or

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if—verbal assessment is given.) Another advantage of a mixed ability group is that the most able students can be used as mentors to the least able. It is well known in educational circles that we learn by doing and by teaching others. Hence the most able students can serve as mentors to enhance their own learning as well as helping their fellow students.

Project choice

Careful choice of a project is required; otherwise teachers may find that the project does not proceed very well and in some cases not succeed at all. Whether students choose projects on their own or in conjunction with their teachers, clearly defined objectives for the projects are essential.

Teachers vary in their opinion of projects and in particular the assessment of these projects. A great deal depends on whether projects are introduced for examination purposes or for instructional reasons. If the projects are part of an examination syllabus the assessment structure should be followed as stated in the syllabus. When projects are not part of a formal examination, an appropriate model for assessment can be used. These projects can be assessed in stages or at the end, depending on the teacher's preference.

Teachers have found that a successful project begins with a clear problem scenario, with precise goals identified. From this a detailed outline of work can be produced. For example, a group of 16-year-old students decide to investigate their fellow students' smoking habits. This in itself is a project beginning, but further classification is needed. Some projects that have been successfully completed by students in the United Kingdom (UK) are:

- Predicting the Top 20 Pop Records in the Music Charts
- The number of cashiers required at a supermarket
- Students' examination marks
- School dinner meal selection
- Students' smoking habits
- Newspaper readership
- Students' perception of gambling
- Simulation using random numbers
- Comparison of photograph sizes in different newspapers.

This list is by no means exhaustive, and many more projects can, and indeed should, evolve from students' own interests. Students should be encouraged to collect and assess data arising from an area of interest and to explore different ways of organising and representing it. It is not essential for students to collect their own data; successful projects can be completed by using data from other sources. Two examples of this are as follows:

Example 1:

A charity fun run took place on 11th August 1994 and the following data was obtained on each of the runners: Name, gender, age, time taken to complete the race, amount of money raised, and charity to which money is to be paid. Use the data stored in the "computer file xxx" to produce a report for the local press and for the Charity Fun Run Newsletter.

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Statistics on the amount of money raised for each charity, the number of male and female runners, and other characteristics could be produced; it was up to the students to decide how to present the information in terms of graphical, numerical and analytical form.

Example 2:

The file “student-data” contains 99 fields of information, collected via questionnaire, on students who have just enrolled in a university computer studies course. Use this data to answer a question of your choosing about these students. The responses to the questionnaire could be examined in many ways, but you are asked to consider one aspect of the data in depth. Some areas of interest are as follows:

1. What is the pattern of academic qualifications obtained and is it related to age and gender?
2. Can an overall score for mathematics experience be constructed? If so, is it related to age or gender?
3. What is the “catchment area” for the course? That is, which geographical regions do new recruits come from? Are there any special characteristics of recruits from certain regions?

These are just some examples that were given to the students. They were also given a copy of the questionnaire and an explanation of all the fields concerned in the data file.

Example 1 is of a prescribed nature and would allow students to decide what statistics to use and to produce their own personal report, whereas example 2 encourages the students to decide on an area of interest to look at and decide what data from the file is to be extracted. These two examples must analyse previously collected data. If this is not practical or feasible in your organisation the best way is to encourage students to collect their own data. Both of the above examples assume students have access to the data electronically and can make use of relevant computer software packages for statistics. Simple data sets can also be arranged for manual computations.

STAGED ASSESSMENT

Assessment can take many forms; for example, a project can be assessed at completion or may be assessed in stages. Different models of assessment may be used. How these are assessed vary as to how the models are structured and the relevant weightings/grades that are assigned to the various parts of the project. A good motivation factor is to assess the projects in stages since this gives students an indication on their progress and induces them to continue with the work.

The purpose of staged assessment (or assessment in stages) is to provide feedback for students at various points throughout the project. This enables students to attain the maximum benefit and guidance throughout the project period. Consider the following problem:

A ferry boat sells a variety of different tickets, such as one-day return, cheap (reduced) day return, weekly ticket, monthly ticket and one-way tickets. The ferry company wants statistics collected for a management report.

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The first part of the project is to identify what statistics the company requires and how these are to be collected. A grade could then be given for this first analysis section of the problem. If the student has left out some of the analysis (for example, the times when cheap day tickets operate), the teacher can provide this information and the student can proceed to the next stage.

The student then has the opportunity to attain the maximum mark possible for the next stage and so on. The next stage may be to design a “data capture” form to collect these statistics. Since the student has a detailed scenario to work on s/he can proceed to design the form with all the information present. Students can then improve their projects as part of the ongoing process. This is an example of a formative approach to provide helpful and detailed feedback about a student’s progress. Caution should be applied when giving feedback, especially for staged assessment, that the giving of inflated predicted grades in order to sustain optimism and motivation by some teachers will raise as many problems as it solves.

“Motivated experience results from the exposure of learners to tasks which enables them to satisfy particular needs and hence gives rise to feelings of satisfaction when the objective is attained.” (Walklin, 1991).

Staged assessment models

The two models we describe below, i.e., the ADIE model (Analysis, Design, Implementation and Evaluation) and the 4P model (Project log, Project report, Practical development and Presentation), have marks allocated for the four stages. The ADIE model was designed to be used by individual students, whereas the 4P model was originally designed for group projects.

The 4P model has a 15% weighting attached to the presentation, whereas the ADIE model does not have a specific grade allocated to a presentation. If the ADIE model is to be used, an additional mark of 10 could be allocated to a presentation, using the 4P Model’s criteria.

A teacher must decide what type of assessment structure is to be used. What follows is a brief introduction to 2 models that have been developed and could be used. It may be more appropriate to use some of the above ideas and adapt them to suit the project work undertaken and facets to be covered. Note that both models allow for assessment of the quality of four stages of work.

The ADIE model

Each problem needs to be analysed first in order to design what data needs to be collected. A good project starts by analysing the problem and addressing the issues of interest or concern. Design of data collection and techniques to be used in data collection follows the analysis. The statistical routines and methods are then carried out with an evaluation of the whole process at the end. Hence, each section could be graded separately, giving feedback to students in stages. If required, the project could be graded at completion using this model. The ADIE model was developed by the Northern Examinations Board (1988) and can be used with the weightings given below. These allow for a maximal score of 40, but could be proportionally changed to be on a 0-100 scale.

Analysis (max. 10 marks)

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Full, or near complete, logical breakdown.	9, 10
Reasonably full, clear and well thought out breakdown.	7, 8
Fairly clear thought out attempt.	5, 6
Partially successful attempt.	3, 4
Limited attempt.	1, 2
Not attempted.	0

Design (max. 8 marks)

Accurate, detailed. Follows closely from analysis. Revised as, and if, necessary in light of other stages.	7, 8
Reasonably accurate, detailed. Analysis considered. Some revision undertaken if needed.	5, 6
Adequate attempt showing some links with analysis.	3,4
Some listing of resources.	2
Limited attempt.	1
Not attempted.	0

Implementation (max. 14 marks)

Follows closely the design, uses appropriate techniques with skill and understanding to produce a good solution.	12-14
Mostly follows the design and appropriate techniques used with reasonable skill and understanding.	8-11
Some linking to design and techniques used with some understanding.	5-7
Techniques applied with some success.	3,4
Some techniques undertaken.	1,2
Not attempted.	0

Evaluation (max. 8 marks)

Clearly relates solution to the problem. Shows a good understanding and appreciation of the solution.	7,8
Reasonably clear reference between the solution and the problem and some appreciation of the solution.	5,6
Some linking of solution to problem.	3,4
Mainly concerned with technical aspects.	2
Statement of what has been done.	1
Not attempted.	0

Each stage above can be assessed and graded separately. The solution can, and often does, involve several statistical techniques being employed. For example, a study taken on consumer food expenditure in a local shop may involve the collection of the amount spent by each customer and what items were purchased. The solution may be to produce a time chart of daily

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takings at the shop, the average amount spent per day by customers, and a bar chart of the number of customers per day. These are by no means the only statistics that could be undertaken but serve as an example to demonstrate what a solution could contain.

The 4P model

The 4P model was developed at South Bank University (Elliott & Starkings, 1994) and is assessed in each of the 4 stages. Suggested weightings are: Project Log 20%, Project report 25%, Practical development 40% and Presentation 15%. The project log is assessed on an individual basis, thus allowing for individual members within groups to be assessed this way. The assessment will take into consideration the individual student's involvement in the group and his/her individual effort and contribution to the overall project. The mark is to be made on continuous assessment, determined by the supervising teacher during the project's time span. In making a judgement the supervisor should refer to the content and accuracy of the student's individual logbook, which each group member keeps during the project life time. When grading the student's project log and the group writing project, the following should be taken into account:

Project Log:

- a. The individual student's effort and commitment.
- b. The quality of the work produced by the individual student.
- c. The student's integration and co-operation with the rest of the group.
- d. The completeness of the logbook.

Written Project Report:

- a. Introduction.
- b. Project specifications.
- c. Statistical techniques used and calculations.
- d. Solutions to the problem.
- e. Recommendations and conclusions.

In addition to these components, practical development (computational steps and other "technical" activities) should be marked with regard to the written report. The presentation of the project to teachers and fellow student groups of the same institution should also be marked. Points to be considered in these areas are:

Practical Development:

- a. The group's investigation of the practical aspect (as evidenced in the report).
- b. Integration of the practical development with the rest of the project.
- c. The group's/individual analysis and design of the problem.
- d. The group's/individual attempt at practical development.

Project Presentation:

- a. General quality of the presentation.
- b. Integration and teamwork.
- c. Interest, content and originality.

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- d. Use and quality of the statistics.

This model allows for staged assessment, but obviously parts are linked and may provide a more suitable model for an end of project grading. These models are an indication of what can be done to assess projects and provide a framework on which teachers can develop their own project work.

PRESENTATIONS OF PROJECTS

The presentation of projects is not always a criteria that is applied in assessment, particularly one of a statistical nature. A structure that the author has developed in the UK highlights certain areas that can be used to assess the verbal presentations of the student's projects. One of the main purposes of the presentations is to help students develop and improve their communications skills. Students need to be able to communicate technical or numerical data in everyday life. Students need to be able to explain and describe statistical methods and results, and this is a skill that is not very often tested in syllabuses (course plans). The structure shown below could be used to assess the non-statistical aspects of a presentation. The presentation structure considers and awards grades on an equal weighting as follows (each element gets an equal weighting):

- a. Relationship to the audience: Appropriate material used, clear message and recommendations that are meaningful.
- b. Use of supporting materials and useful aids to communication: Use of appropriate media for demonstration, handouts, etc.
- c. Structure: Introduction, middle, summary, and conclusion.
- d. Handling questions: Thoughtful and honest responses, appropriateness of answers and convincing arguments.
- e. Time Management: Presentation too long, too short, or appropriate.

The relationship to the audience is important since in real life being able to communicate effectively to get point(s) across is an essential skill to have acquired. To be able to display information using appropriate diagrams, graphs, or other such statistical knowledge is a useful technique and should be graded accordingly. Handling questions is a competency students will need to acquire in various aspects of their future studies and beyond and hence should be encouraged. Students will need to be able to manage effectively their own time in many aspects of life, whether it be for a timed examination or presentation.

The drawback with this type of assessment is that personal knowledge of a student's progress can often inhibit the successful marking of the presentation. It is advisable to have, if possible, a team of graders to provide input on various facets of the assessment structure. This will allow for a wider and much broader opinion and to achieve consistency and consensus between the presentations. Presentations are expensive in terms of assessor's time and tend to be subjective, and students do not always like the idea of standing up in front of their class and teachers. However, a well organised project plan and relaxed atmosphere in the room used for these presentations should help to overcome this. The benefits that can be obtained from this type of assessment far outweigh the disadvantages.

TEACHING STRUCTURE

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Project work does not necessarily mean that all teaching in that subject ceases. Teaching often continues and some time should be set aside during each class to complete the project. During the project time the teacher becomes a facilitator of learning and aims to become an equal participant in the inquiry process. The roles of the teacher and student become more mutually supportive rather than separate. Rather than explaining the answer to a specific problem, the teacher serves as a guide and advisor. This enhances the readiness of students to learn in a self-directed way, and enables them to become progressively responsible for their own learning and development and to use their own experience as the relevant starting point for structuring learning.

If teaching continues as a project gets underway, the relevant knowledge that is required by the students to start the project should have been covered previously. If the subject matter has not been addressed previously by the teacher, problems of project selection and methods chosen to implement the solution, may be severely hampered. Careful project development planning is vital and builds upon good practice that has been established in the classroom. This planning provides a means of supporting the students in developing their projects as it enhances existing teaching. It also enables students to identify personal, educational, and vocational goals and draw up plans through which these goals can be realised.

When teaching has been completed and project work takes up the entire time there are several points, listed below, that need to be considered.

- All students should be engaged in meaningful activities. The teacher should monitor groups to prevent one member of the group doing most of the work while the rest do very little.
- Motivation of students needs to be a paramount issue, since the enthusiasm that may have prevailed at the start of a project may start to diminish over time unless monitored sufficiently by the teacher.
- The amount of time spent on a project necessitates careful planning, otherwise other lessons may suffer as a result of students over-indulging in the activities of the project to the disadvantage of other subjects or classes.
- Supervision of the projects is vital and stages of work should be observed and graded systematically, recorded and reported back to student project groups.

The above points may also relate to projects where teaching is taking place but experience has shown that these items are more prevalent when teaching has ceased. In the UK it has been recommended that project work is not left to be undertaken at the end of a course but rather an integral part over the duration of the course.

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Students can use the following type of outline to focus their attention on the various areas of project work to be completed. Further discussions can take place with the teacher as required during the progression of the project.

1. Group discussion of what they wish to find out and how to proceed.
2. Draft questionnaire to be produced.
3. Pilot of the questionnaire.
4. Revised questionnaire in light of the comments received for the pilot.
5. Full sample taken.
6. Analysis of results.
7. Production of report and materials used for presentation.

The use of a help factor

We must keep in mind that the problem of providing instructions for students is to avoid telling them so much that interest is lost or telling so little that they do not know what is expected of them. A possible scheme for enabling students to get a good start to a project is to make use of a “help factor.” For example, consider a situation where the ADIE model is used for assessment with respective maximum grades being:

Analysis	Design	Implementation	Evaluation
10	8	14	8

For each section a help factor can be applied with suggested weightings, as shown in Figure 1.

No help				Total help
1	0.8	0.6	0.4	0

Figure 1: Help Factor

This means that if a teacher gives just a little bit of help in a particular stage (say, Analysis of Problem), the score for this stage will be 0.8 of what it should be. If a teacher gives a considerable amount of help to a student, then the help factor would be 0. Although this may mean that a student effectively receives no grade for a stage, it is still possible to attain high grades in the other sections. An example of this usage, which has been adopted by some of the independent examination boards in the UK for project grading, is shown in Figure 2.

Component	Possible Grade	Grade Given	Help factor	Adjusted Grade
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Analysis	10	10	0.6	6
Design	8	6	0.4	2.4
Implementation	14	12	1.0	12
Evaluation	8	6	0.6	3.6

Total				24
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Figure 2: Example of Help Factor

FEEDBACK

The assessment of projects is clearly a complex matter and there is no single agreed way of achieving this with total success. Different philosophical perspectives interact with different practical constraints to produce a variety of procedures to follow. The teacher must decide which is the most appropriate method to use under the circumstances.

The purpose of assessment is to provide information about the students who have been assessed. Feedback should be given as soon possible after the project has been graded. Feedback can be negative as well as positive since students need to know their strengths and weaknesses. If a staged assessment is used feedback can be given at the end of each stage so that students know exactly what grades they have achieved up to that point.

Incentives are often given in everyday life to encourage people to complete a certain task. As an example, Ford Motor Company recently sent out a market research questionnaire to car drivers with the incentive being a free music cassette for every completed questionnaire that was returned. In the case of students' projects, a prize of a book token could be used to induce motivation. Competition plays an ever increasing role in society and students seem to accept this fact and appear to be happy to compete for some form of reward. Nationally, in the UK, the annual statistics competition provides prizes for the best statistical projects for different age groups. This scheme has been very successful. This is not practical for all project work but, if possible, it is a method worthy of consideration.

Verbal feedback is a method by which a student can respond immediately to correct errors in the project and prevent future mistakes. Feedback provides a useful mechanism for delivering comments which may be lost in the formal grading scheme. This method can be used by teachers and students alike to create an atmosphere of encouragement and learning.

IMPLICATIONS

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For any teacher undertaking to use project work within their courses there are several issues that need to be considered. These issues are summarised below:

- Whether projects are to be undertaken by individual students or groups of students.
- If group projects are used group formation needs to be decided.
- What type of project is to be used, i.e., is the project chosen by the student or set by the teacher?
- How the project is to be assessed. Students should be aware of this structure.
- Time available to complete the project should be stated, thus enabling students to organise their workload.
- Who is responsible for supervision and smooth running of the projects.
- How the project work fits in with the overall structure of the course. What teaching will take place both before commencement of the project and during the projects' time span.
- Students embarked on a project will need to be given access to sources of information and other materials that will enable them to work at an appropriate pace.

Teaching, if it continues during the project, needs to be structured so that students can get the maximum benefit from the project and the classroom teaching. If teaching has finished, then motivation of the students is a paramount factor. If students lack motivation this could lead to the project being very weak. Project work should be an active method of learning, requiring decision making and problem solving on the part of the student in "real life" situations. Where students have chosen their own projects, there is a marked interest and an enhanced motivation factor, and hence should be encouraged where possible.

If mixed ability grouping is used, the distinction between the most and least able students can be blurred, so this type of group work was found to be the most appropriate. Group project work provides an opportunity for students to use real life situations. They also help develop interpersonal relationships through understanding of the other student's point of view.

Projects that do not succeed are because students fail to start with precise aims and objectives. Since assessment systems play such an undeniable role in determining how learners and teachers spend their time, it is crucial that such systems focus on what we actually want learners to be good at. For a project to be successful, teachers should ascertain that students are able to:

- Solve novel problems, best chosen by the students themselves (see list above), but possibly devised by teachers, using facts and principles previously encountered.
- Devise an approach to investigate the chosen problem using appropriate tools and techniques.

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- Keep adequate details of all work attempted and completed.
- Use appropriate procedures and formulae when calculating results.
- Communicate results obtained in the most appropriate manner.
- Discuss the results and inferences/conclusions obtained.

This model is by no means the only way of advising students doing project work. But it will give the students and teachers a framework on which to build and hence minimise the probability of a project failing. If students start with a clear problem scenario and with precise goals to achieve, and produce a detailed outline of work to be carried out, a successful project should result.

If we carefully guide our students as they develop projects, with clearly defined aims and objectives, project work allows for the integration of several previously encountered techniques. It may also be designed as a learning process in which students are faced with new concepts and unfamiliar activities. A point made by Kelly (1978) which is worth remembering is that assessment is a method of teaching, not an alternative to teaching.

Since education is our chief concern, one of our main goals must be the autonomy of the learner. Project work is a means by which this autonomy can be developed. The use of project work to create a situation in which students' learning is increasingly self-directed and self-propelled is highly recommended.