

# Chapter 23 Internal assessment

## 23.1 Why is there a project in this course?

The project is intended to give you the experience of doing an extended piece of mathematics. A good project should help to convince you that mathematics is not a list of 'sums' with right or wrong answers but, instead is, a useful skill that will continue to be relevant to you after you have completed your diploma. A successful project will show you that mathematics is a valuable analytical tool that can assist you in future studies as well as in your career.

As part of the course:

- Your project accounts for 20% of your final mark.
- There are a total of 20 possible marks for your project (with no partial marks).
- The syllabus allocates 25 teaching hours for the project. This includes time for you to look at examples of past projects, study the marking criteria and discuss a suitable focus of study with your teacher.
- The project should be approximately 2000 words in length, excluding diagrams, appendices and bibliography.
- If you do not submit a project, you will not receive an overall grade for this course.

## 23.2 How do I start?

You should start thinking about your project during the first year of your course, even if you do not expect to complete the work until you are in your second year.

To help you get started:

- Ask your teacher to show you some past projects. If you look at them in class, you can also discuss them with your teacher and fellow students.
- Study the marking criteria and make sure you understand what is expected. Try marking some past projects according to the assessment criteria. You could do this together with a few other students so that you can discuss the projects you are reviewing and whether or not you think they have met the criteria.
- Re-examine past projects and make a note of anything that impresses you, or anything that you think could have been improved.

- Think about an aspect of mathematics that you particularly enjoy and feel comfortable with, or do you have a favourite sport or hobby that you could use as a basis for your project?

### 23.3 Is my topic a good one?

Finding a good topic is the hardest part of the project. Once you have an idea, discuss it with your teacher, who can advise and guide you through the process of formulating a theme for your project. The International Baccalaureate Organization publishes a list of titles of successful past projects, which you can look at to get some ideas.

Make sure that:

- your chosen project will involve enough mathematics to demonstrate your level of skill; an idea may seem really interesting, but consider whether its interest is more artistic or historical than mathematical
- you can clearly identify a ‘research question’ within your chosen topic and that you will have enough mathematical knowledge to explore it in depth
- the topic actually interests you — you will not feel motivated to spend time on something that bores you or seems pointless.

### 23.4 What is the structure of the project?

Your project should have a logical structure so that your analysis and conclusions are easy to understand.

Make sure that your project contains:

- an appropriate title
- a clear statement of your task and a plan for how you are going to approach it
- the information or data that you have collected and have analysed mathematically
- your analysis of the information or data collected; there are many ways in which you can present this — just be careful to always use the correct mathematical notation
- your interpretation of the results and a discussion about their validity or whether you suspect bias or other faults
- your conclusion — have you answered the question that you started out with? Have you discovered anything that surprises you?

## 23.5 What are the assessment criteria?

Your project will be marked by your teacher according to a set of official criteria.

	Criterion	Maximum mark
A	Introduction	3
B	Information and/or measurements	3
C	Mathematical processes	5
D	Interpretation of results	3
E	Validity	1
F	Structure and communication	3
G	Notation and terminology	2

After your teacher has marked all the projects for his/her class, a sample of the projects will be sent to an IB moderator. This means that someone who does not know the students in person will mark the projects again. This checking procedure is intended to ensure that all projects, from all over the world, are marked to the same standard.

### Criterion A. Introduction

You should aim to get top marks for this criterion. To achieve the full 3 marks, you need to give the project a suitable title, provide a clear statement of the task you are undertaking, and write a detailed plan of how you will approach the task, the techniques you will use and the reasons for choosing them. If your work is based on a specific research question or null hypothesis, this is where you should state it.

Although it's a good idea to start with a detailed plan, some projects change considerably during the course of the investigation. It is fine to adapt your plan while you are working on the project, but when you have finished, remember to go back and make sure that your introduction still fits.

### Criterion B. Information and/or measurements

It is important that you collect enough information but not too much. It is as easy to be overwhelmed by too much material as it is to be stuck because you have not collected enough. How much is enough? This is a difficult question as it depends on the individual project, so don't be hesitant to check with your teacher.

If you collect your own information, make sure that all of it is relevant and that you are aware of any bias or faults in your selection methods. If you have used a questionnaire to collect data for statistical analysis, include a copy of it with your project, but do not attach all the completed questionnaires.

If you are using secondary data, make sure that you have explained where you found it, and give the references to any books, periodicals

or websites that you used. You may have so much secondary data that you have to work with samples, in which case you need to describe any sampling techniques that you have used.

Once you have assembled all your information or measurements, organise it in a form that is straightforward to understand and analyse. Remember that your project may be sent to the IB moderator, so you, your teacher and the moderator must all be able to make sense of your material easily.

## Criterion C. Mathematical processes

This is the core of your project and the section on which you will spend the most time. Think of your mathematics as something that will develop as you work, so don't be tempted to begin your project with a complicated technique. The key word in this criterion is 'relevant': the mathematical processes that you use must be directly related to and appropriate for your project.

Here are some tips to guide you in this part of the project:

- Start with simple processes that you are confident about — and keep checking at each stage that your working is correct.
- Draw diagrams or graphs where they can illustrate and explain your methods.
- If you are using formulae, quote them and show how, and why, you have used them.
- Don't keep repeating the same process. Some projects may require repetition, but after you have worked through a process once and explained it clearly, any further applications of the same procedure should be presented concisely, for example using technology, with the results summarised in tables.
- Once you have a solid foundation for your work, you can move on to other, more complicated, techniques; but still make sure that these are relevant and that you have explained why you are using them. There is no merit in doing something complicated just because you can.
- If something unexpected happens, do not ignore it. For instance, if a scatter graph shows little correlation, or a correlation coefficient turns out to be very small, there is no point in continuing with your original plan to calculate a regression line. Instead, explain why you have not obtained a line of best fit; this demonstrates that you actually understand the concepts behind a technique. In fact, it can be really useful when things do not go as you expect, since it gives you plenty of scope to discuss why that might have happened.
- To gain the highest possible mark for this criterion, you are expected to build on the simple processes that you started with by using at least one further, more complex, process. This further process must, as always, be relevant and correctly applied.



## Criterion D. Interpretation of results

To satisfy this criterion, you need to discuss the mathematics that you used to obtain your results, why you used it, and what the results tell you.

You can include here a discussion of anything unexpected that you found. The recognition that your calculations produced an unexpected result is already valuable, but you also need to discuss possible reasons for why this could have happened.

To gain the highest mark for this criterion, you must discuss your results in a meaningful way, making sure that your conclusions are consistent with the mathematics that you used and are interpreted in the context of the question or task stated in the introduction. If your project is too simple, you will find this difficult to do.

## Criterion E. Validity

This criterion is easy to miss; some students think that it is irrelevant to their project and that they can ignore it.

For most projects you can discuss the accuracy of the measurements, or any bias that may be present in your data.

Assessing the validity of your information or methods is also an opportunity to examine anything that went wrong and to show what you learned from any mistakes.

If you are quite sure that the validity of information and techniques is not relevant to your project, make sure that you state this and give your reasons for believing so.

As part of this criterion you can also discuss whether and how your project could be improved or extended. However, be sure that you give clear reasons; 'I could improve this project if I had more time' will not be considered sufficient!

## Criterion F. Structure and communication

This criterion follows on from criteria A, D and E. If you started with a clear, detailed plan and have been able to follow it, then the structure of your project should be good. If you have given a coherent discussion of your results and their validity, then you have communicated well.

Look at any graphs or diagrams: have you given each one a title and labelled them correctly? Is it clear why they are included in that place and what they are meant to illustrate? Are your calculations correct and is it obvious how you did them? If you used a computer or GDC for most of your calculations, make sure you have explained clearly how, and why, you used that technology.

Reread your project and make sure that it flows well and that your discussions are in the right place and are easy to follow. It is a good idea to ask a non-mathematician to read your project. They should be able to see clearly why you did the project and what you found out by doing it. They may not understand the maths you used, but your project should give them confidence that you do know what you're doing; they should

not drop to sleep with boredom trying to read through 20 pages of data or endless repeats of similar calculations!

Have you cited properly any resources that you used? Remember that if you need to add an appendix containing references, it will not be included in your word count.

When you are sure that your project is complete, ask other people to read it. If you can convince someone (other than your teacher or your best friend) that your project is well-structured and interesting, well done!

### Criterion G. Notation and terminology

If you are very skilled with your GDC or computer, it is quite easy to lose marks by using incorrect notation. Any variables you use should be defined clearly. Remember that calculator notation is not acceptable in either the examinations or the project. Technology can be an important tool while you are working on your project, but you are still expected to use correct notation and mathematical vocabulary when writing up your results.

## 23.6 What do I do when I have finished my project?

If you have done your entire project on a computer, ensure that you have made a back-up copy before you submit it to your teacher.

If you have used a combination of computer-generated and hand-drawn charts or diagrams, save back-up copies of the electronic ones and scan or keep photocopies of anything that you drew on paper.

Your teacher will give you a form to sign. This requires you to verify that the work is entirely your own and that you have acknowledged the use of any material, whether written or visual, that belongs to another person. Plagiarism is taken very seriously by the IB. The unauthorised use of another person's material will result in your project being disqualified.

After you have submitted your project, it will be marked by your teacher according to the criteria described above, and it may be included in the sample sent to an IB moderator for re-marking.

You can now move on to the rest of your course!