11 Project

CHAPTER OBJECTIVES:

As part of your Mathematical Studies course, you need to write a project that is assessed and counts towards your final grade.

This chapter gives you advice on planning your project, as well as hints and tips to help you get a good grade by making sure your project satisfies the assessment criteria, suggestions for project topics, and a useful checklist to help you ensure your final project is complete.

11.1 The project

The project is an opportunity for you to show that you can apply mathematics to an area that interests you.

The project is worth 20% of your final grade so it is worth spending time on it.

You should aim to spend:

You can't receive a grade for Mathematical Studies SL if you don't submit a project.

25 hours of class time	25 hours of your own time
• Discussing the project and the assessment criteria • Looking at and 'marking' previous projects • Discussing suitable titles • Discussing methods of data collection and sampling • Discussing your progress with your teacher	• Planning your project • Collecting and organizing data • Applying mathematical processes • Discussing results and validity • Making sure your project is well structured and reads well • Checking that your mathematics, notation and terminology are correct

Your school will set you deadlines for submitting drafts and the final piece of work.

If you do not submit a project then you will receive a grade of "N" for Mathematical Studies SL, which means you automatically fail your Diploma.

Every candidate taking Mathematical Studies SL needs to submit a project. Make sure that you know your school's deadlines and keep to them.

11.2 Internal assessment criteria

Your project will be moderated by your teacher against given criteria. It will then be externally moderated by the IB using the same assessment criteria.
The final mark for each project is the sum of the scores for each criterion.
The maximum possible final mark is 20.
This is 20% of your final mark for Mathematical Studies SL.

The criteria are split into seven areas, A to G:

Criterion A	Introduction
Criterion B	Information/measurement
Criterion C	Mathematical processes
Criterion D	Interpretation of results
Criterion E	Validity
Criterion F	Structure and communication
Criterion G	Notation and terminology

Make sure you understand these criteria and consult them frequently when writing your project. Marking someone else's project against the criteria will help you to understand them. There are some projects to mark on the CD.

Criterion A: Introduction

In this context,

- "task" means "what the student is going to do"
- "plan" means "how the student is going to do it".

A good project should be clear and easily understood by a non-mathematician, and self-explanatory all the way through.

Achievement level	Descriptor
0	The project does not contain a clear statement of the task. *There is no evidence in the project of any statement of what the student is going to do or has done.*
1	The project contains a clear statement of the task. *For this level to be achieved the task should be stated explicitly.*
2	The project contains a title, a clear statement of the task and a description of the plan. *The plan need not be highly detailed, but must describe how the task will be performed. If the project does not have a title this achievement level cannot be awarded.*
3	The project contains a title, a clear statement of the task and a detailed plan that is followed. *The plan should specify what techniques are to be used at each stage and the purpose behind them, thus lending focus to the task.*

Every project should start with a clear statement of the task and have a clear title.

Your project

To get a good mark for Criterion A: Introduction

Make sure that you have:

A title page

This needs to include a clear title, your name and candidate number, the date, the subject and your teacher's name.

An introduction

- ✓ This needs to state exactly **what** you are going to do and why.
- ✓ You need to also state **how** you are going to achieve this aim, which mathematical processes you will use and why you have chosen those processes.
- ✓ Remember, if you do not do everything that you say you will do, you will not receive full marks for this criterion!

Criterion B: Information/measurement

In this context,

- "information or generated measurements" means information or measurements generated by computer, by observation, by investigation, by prediction from a mathematical model or by experiment
- "mathematical information" includes geometrical figures and data collected empirically or assembled from outside sources. It does not just mean data for statistical analysis. If you use a questionnaire or survey, make sure you include a copy of this along with the raw data.

Achievement level	Descriptor
0	The project does not contain any relevant information collected or relevant measurements generated. *No attempt has been made to collect any relevant information or generate any relevant measurements.*
1	The project contains relevant information collected or relevant generated measurements. *This achievement level can be awarded even if a fundamental flaw exists in the instrument used to collect the information, for example, a faulty questionnaire or an interview conducted in an invalid way.*
2	The relevant information collected, or set of measurements generated, is organized in a form appropriate for analysis or is sufficient in both quality and quantity. *A satisfactory attempt has been made to structure the information/measurements ready for the process of analysis, or the information/measurements collection process has been thoroughly described and the quantity of information justified. The raw data must be included for this achievement level to be awarded.*

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Achievement level	Descriptor
3	The relevant information collected, or set of measurements generated, is organized in a form appropriate for analysis and is sufficient in both quality and quantity. *The information/measurements have been properly structured ready for analysis and the information/measurements collection process has been thoroughly described and the quantity of information justified. If the information/measurements are too sparse or too simple this achievement level cannot be awarded.* *If the information/measurements are from a secondary source then there must be evidence of sampling if appropriate. All sampling processes should be completely described.*

Your project

To get a good mark for Criterion B: Information/measurement

- ✓ Gather your information/measurements from a survey, a questionnaire, calculation, the internet, etc.
- ✓ Make sure you collect sufficient information/measurements to perform the mathematical processes you mentioned in Criterion A.
- ✓ Include all your raw information/measurements in the project – you can put this in an appendix if you wish.
- ✓ Make sure that the information/measurements you collect are relevant and organized ready for use.
- ✓ Reorganize the information/measurements each time to suit the calculations you do.
- ✓ Remember to include a copy of your survey or questionnaire, if you used one to collect your information/measurements.
- ✓ If your information/measurements are taken from a **secondary** source then you need to describe any sampling process that you used.
- ✓ You can also use mathematical processes that are not in the Mathematical Studies SL syllabus.

Criterion C: Mathematical processes

When presenting data in diagrams:

- Use a ruler and don't just sketch. A freehand sketch would not be considered a correct mathematical process.
- If you use technology to create your diagram, you need to show a clear understanding of the mathematical processes used.
- All graphs must contain all relevant information.

Achievement level	Descriptor
0	The project does not contain any mathematical processes. *For example where the processes have been copied from a book with no attempt being made to use any collected/generated information.* *Projects consisting of only historical accounts will achieve this level.*
1	At least two simple mathematical processes have been carried out. *Simple processes are considered to be those that a mathematical studies student could carry out easily; for example, percentages, areas of plane shapes, graphs, trigonometry, bar charts, pie charts, mean and standard deviation, substitution into formulae and* ***any*** *calculations/graphs using technology only.*
2	At least two simple mathematical processes have been carried out correctly. *A small number of isolated mistakes should not disqualify a student from achieving this level. If there is incorrect use of formulae, or consistent mistakes in using data, this level cannot be awarded.*
3	At least two simple mathematical processes have been carried out correctly. All processes used are relevant. *The simple mathematical processes must be relevant to the stated aim of the project.*
4	The simple relevant mathematical processes have been carried out correctly. In addition at least one relevant further process has been carried out. *Examples of further processes are differential calculus, mathematical modeling, optimisation, analysis of exponential functions, statistical tests and distributions, compound probability. For this level to be achieved it is not required that the calculations of the further process be without error. At least one further process must be calculated showing full working.*
5	The simple relevant mathematical processes have been carried out correctly. In addition at least one relevant further process has been carried out. All processes, both simple and further, that have been carried out are without error. *If the measurements, information or data are limited in scope then this achievement level cannot be awarded.*

If a project contains no simple mathematical processes then the first two further processes are assessed as simple.

The teacher is responsible for determining the accuracy of the mathematics used and must indicate any errors on the final project.

Your project

To get a good mark for Criterion C: Mathematical processes

- ✓ Always include at least two **relevant** simple mathematical processes.
- ✓ Always put scales and labels on your graphs.
- ✓ State which process you are going to use and why.
- ✓ Discuss the validity of these processes.
- ✓ Check to make sure that your results are accurate.
- ✓ Check that your results are sensible.
- ✓ Comment on your results.
- ✓ Introduce at least one **relevant** further mathematical process.
- ✓ State why you are using this further process and make sure that it is relevant and valid.
- ✓ For both simple and further processes, make sure that you do one calculation of each process by hand. You can use your GDC to perform similar calculations.
- ✓ If you find the standard deviation then comment on it.
- ✓ For the chi-squared test to be valid the entries must be frequencies – not raw data or percentages, and, if the degree of freedom is 1, then Yate's continuity correction should be applied. No expected values should be less than 5.
- ✓ For linear correlation there is no point finding the equation of the regression line if the correlation coefficient is weak or if you can see from the scatter diagram that there is no correlation.

Criterion D: Interpretation of results

Achievement level	Descriptor
0	The project does not contain any interpretations or conclusions. *For the student to be awarded this level there must be no evidence of interpretation or conclusions anywhere in the project, or a completely false interpretation is given without reference to any of the results obtained.*
1	The project contains at least one interpretation or conclusion. *Only minimal evidence of interpretation or conclusions is required for this level. This level can be achieved by recognizing the need to interpret the results and attempting to do so, but reaching only false or contradictory conclusions.*
2	The project contains interpretations and/or conclusions that are consistent with the mathematical processes used. *A "follow through" procedure should be used and, consequently, it is irrelevant here whether the processes are either correct or appropriate; the only requirement is consistency.*

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3	The project contains a meaningful discussion of interpretations and conclusions that are consistent with the mathematical processes used. *To achieve this level the student would be expected to produce a discussion of the results obtained and the conclusions drawn based on the level of understanding reasonably to be expected from a student of Mathematical Studies SL. This may lead to a discussion of underlying reasons for results obtained.* *If the project is a very simple one, with few opportunities for substantial interpretation, this achievement level cannot be awarded.*

Your project

To get a good mark for Criterion D: Interpretation of results

- ✓ After every graph or calculation make a comment – are your results what you expected? Are they meaningful?
- ✓ Always give a thorough and detailed analysis of **all** your results.
- ✓ Make sure that you "follow through" with the results of your mathematical processes. Even if your mathematics contains errors, as long as your interpretation or conclusion follows on from that wrong answer then you will be awarded the marks.
- ✓ Make sure that your project is not a "simple one" with only a few simple mathematical processes. If there are only a few processes then there is very little to comment on. This is also the case when the project is very short.

Criterion E: Validity

This criterion looks at whether appropriate techniques were used to collect information, whether appropriate mathematics was used to deal with this information and whether the mathematics used has any limitations in its applicability within the project. Any limitations or qualifications of the conclusions and interpretations are also judged within this criterion.

Achievement level	Descriptor
0	There is no awareness shown that validity plays a part in the project.
1	There is an indication with reasons if and where validity plays a part in the project. *There is discussion of the validity of the techniques used or recognition of any limitations that might apply. A simple statement such as* *"I should have used more information/measurements" is not sufficient to achieve this level. If the student considers that validity is not an issue, this must be fully justified.*

Your project

To get a good mark for Criterion E: Validity

- ✓ Discuss the validity of any techniques you have used – are they appropriate to the situation?
- ✓ Discuss any problems with data collection or samples that might affect the validity.
- ✓ Discuss the validity of the results – can they be interpreted meaningfully?
- ✓ If you think that validity is not an issue in your project then you need to justify this.

Criterion F: Structure and communication

In this context "structure" means how you have organized your information, calculations and interpretations. The project should present a logical sequence of thought and activities – starting with the task and the plan, and finishing with the conclusions and limitations.

Avoid large numbers of repetitive procedures.

Make sure all graphs are fully labelled and have an appropriate scale.

Projects that do not reflect a significant time commitment will not score highly on this assessment criterion.

It is not expected that spelling, grammar and syntax are perfect. Your teacher will encourage you to correct any language errors.

Achievement level	Descriptor
0	No attempt has been made to structure the project. *It is not expected that many students will be awarded this level.*
1	Some attempt has been made to structure the project. *Partially complete and very simple projects would only achieve this level.*
2	The project has been structured in a logical manner so that it is easily followed. *There must be a logical development to the project. The project must reflect the appropriate commitment for this achievement level to be awarded.*
3	The project has been well structured in accordance with the stated plan and is communicated in a coherent manner. *To achieve this level the project would be expected to read well, and contain footnotes and a bibliography, as appropriate. The project must be focused and contain only relevant discussions.*

Your project

To get a good mark for Criterion F: Structure and communication

- ✓ Your project should be structured in a logical way.
- ✓ Include the table of the data you will be using before each process.
- ✓ Remember to put scales and labels on your graphs.
- ✓ Your project should "read well".
- ✓ Your project should contain footnotes as appropriate. For example, if you are using a quote from a publication, a formula from a mathematics book, etc., put the source of the quote in a footnote.
- ✓ Your project should contain a bibliography as appropriate. This can be in an appendix at the end. List any books you use (including your mathematics textbook!), any websites you consult, etc.
- ✓ Your project should be focused and contain only relevant discussions.
- ✓ You should be able to give your project to anyone to read and they should understand it without having to ask you any questions.

Criterion G: Notation and terminology

You need to use correct mathematical terminology and mathematical notation. Calculator or spreadsheet notation is not acceptable.

Achievement level	Descriptor
0	The project does not contain correct mathematical notation or terminology. *It is not expected that many students will be awarded this level.*
1	The project contains some correct mathematical notation or terminology.
2	The project contains correct mathematical notation and terminology throughout. *Variables should be explicitly defined. An isolated slip in notation need not preclude a student from achieving this level. If it is a simple project requiring little or no notation/terminology this achievement level cannot be awarded.*

Your project

To get a good mark for Criterion G: Notation and terminology

- ✓ Your project should contain correct mathematical notation and terminology.
- ✓ Do not use calculator notation. For example, use $Z\frac{x}{y}$ and not 2^x; use χ^2 and not X^2; use 0.028 and not 2.8E-2

11.3 Moderating the project

Once you have submitted the final version of your project, your teacher will moderate it. The teacher looks at each criterion in turn, starting from the lowest grade. As soon as your project fails to meet one of the grade descriptors, then the mark for that criterion is set.

The teacher submits these marks to the International Baccalaureate, via a special website. A sample of your school's projects is selected automatically from the marks that are entered and this sample is sent to an external moderator to be checked. This person moderates the projects according to the assessment criteria and checks that your teacher has moderated the projects accurately.

If your teacher has moderated the projects too severely then all your project marks may be increased.

If your teacher has moderated the projects too leniently then all your project marks may be decreased.

11.4 Academic Honesty

This is extremely important in all your work. Make sure that you have read and are familiar with the IB Academic Honesty document.

Your teacher or IB Diploma Programme coordinator will be able to give you this document.

Academic Honesty means:

- that your work is authentic
- that your work is your own intellectual property
- that you conduct yourself properly in written examinations
- that any work taken from another source is properly cited.

Authentic work:

- is work based on your own original ideas
- can draw on the work and ideas of others, but this must be fully acknowledged (e.g. in footnotes and bibliography)
- must use your own language and expression – for both written and oral assignments.
- must acknowledge all sources fully and appropriately (e.g. in a bibliography).

Malpractice

The IB defines **malpractice** as 'behavior that results in, or may result in, the candidate or any other candidate gaining an unfair advantage in one or more assessment components'.

Malpractice includes:

- plagiarism – copying from others' work, published or otherwise
- collusion – working secretly with at least one other person in order to gain an undue advantage. This includes having someone else write your exploration, and passing it off as your own
- duplication of work
- any other behavior that gains an unfair advantage.

'Plagiarism' is a word derived from Latin, meaning 'to kidnap'.

Advice to schools:

- A school-wide policy must be in place to promote Academic Honesty
- All candidates must clearly understand this policy
- All subject areas must promote the policy
- Candidates must be clearly aware of the penalties for academic dishonesty
- Schools must enforce penalties, if incurred.

Acknowledging sources

Remember to acknowledge all your sources. Both teachers and moderators can usually tell when a project has been plagiarised. Many schools use computer software to check for plagiarism. If you are found guilty of plagiarism then you will not receive your Diploma. It is not worth taking the risk.

You will find a definition of plagiarism in the Academic Honesty document.

11.5 Record keeping

Make notes of any books or websites you use, as you go along, so you can include them in your bibliography.

- There are different ways of referencing books, websites, etc. Make sure that you use the style advised by your school and **be consistent**.
- Keep a record of your actions so that you can show your teacher how much time you are spending on your project.
- Remember to follow your teacher's advice and meet the school's deadlines.
- The teacher is there to help you – so do not be afraid to ask for guidance.

11.6 Choosing a topic

You need to choose a topic that you are interested in, because then you will put more effort into the project. Discuss the topic with your teacher to make sure that you can generate sufficient data to perform both simple and further mathematical processes.

Many candidates choose a project based on statistics. Other topics are also suitable, such as optimisation in calculus, modeling equations, quadratics or exponential equations, trigonometry, set theory, probability and finance.

If you cannot think of a topic yourself then ask your teacher to show you the list of topics in the Teacher Support Manual or a list of topics from the Online Curriculum Center. Below are some ideas – perhaps you will find something that interests you here.

PROJECT SUGGESTIONS

- Comparing heights from sports data
- Rollerblading: the mathematics behind it
- Traffic study of Schiphol International Airport
- Is there a connection between the time it takes to get to school and the distance a student lives from school?
- Does gender influence someone's choice of favorite animal?
- The effect of sport on GPA
- Does eating breakfast affect your grade?
- Is there a relation between BMI and hours playing sports?
- The effect of blood alcohol content law on the number of traffic collisions
- M.C. Escher: symmetry and infinity in art
- A statistical investigation of leaves
- Olympic games: track and field times
- Analysis of basic US stocks
- Modeling the decrease in swimming times since the Olympics began
- Examining the relation between lung capacity, smoking and sports
- Relations between international and bilingual students re: jobs, pocket money and spending behavior
- Investing in a hotel in Costa Rica
- Statistical comparison of the number of words in a sentence in different languages

- Teenage drinking and its effect on GPA
- Relationship between unemployment and criminality in Sweden
- How many peas are there in a 500 g box?
- Correlation between women's participation in higher education and politics from 1955–2000
- Investigating eating trends of today's youth
- Correlation study of TV versus sleep times
- Which type of movies do males and females prefer?
- Power to weight ratio
- The Ferris wheel
- The effect that different temperatures have on the level of growth of bacteria in water from a garden pool
- Music and the brain
- Blood pressure and stress levels
- Sunspot cycles
- Public transportation costs and car usage: a personal comparison
- The geometry involved in billiards
- Investigation into different brands of batteries
- Costs of products bought online compared to local grocery stores
- Investigating the most economical packaging for one-litre drink cartons
- Modeling the temperature each week for various cities in the world
- Modeling the trajectory of an arrow fired from various angles
- Modeling the cooling rate of hot drinks placed in different locations
- Investigation of how to get from A to B in New York
- Testing if the weights of 1-kilogram bags of sugar are normally distributed