

# Documenting Programming Projects

## OCR A Level Computer Science H446

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Initial ideas chapter for students considering their project.

The full PDF guide including writing up the analysis, design, coded solution, and evaluation is available for Craig 'n' Dave members.



Craig 'n' Dave

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# INITIAL IDEAS

There are specific examination board requirements you should be aware of before you start your project. It is also important to scope your project to ensure it is manageable in the time you have available.

## Choosing a project

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One of the considerations when embarking on a programming project is ensuring you choose a project with sufficient scope to be of A Level standard; this is not easy to define, but it must be more advanced than typical GCSE work. As a minimum, it must include:

- a graphical user interface; and
- a substantial coded element.

Trivial problems - regardless of how well you solve them and write them up - will not provide you with the evidence you need to meet the top mark band criteria across the whole project.

Consider the complexity of the algorithms you study on the A Level Computer Science course as a benchmark. These include linear search, binary search, hashing functions, bubble sort, insertion sort, merge sort, quick sort, PageRank, Dijkstra and A\* algorithm.

Consider the data structures. These include arrays, lists, graphs, hash tables and trees. A project that does not make use of at least one of these will not attract higher marks. HTML, CSS and SQL are not considered programming languages, so although you might need them for your project, there are no marks awarded for that aspect of the work.

Small applications, teaching tools and simulations are good project ideas. You should avoid multiple-choice quizzes, simple data retrieval systems and projects written in Microsoft Access or Excel with VBA.

## Approved programming languages

You also need to consider the programming language you intend to use. There is a list of approved languages, and your teacher will need to seek permission from the examination board for you to use any language not on the list. Approved languages include Python, C#, C++, Objective-C, Java, Visual Basic, PHP, Dephi, Robot-x, Monkey-x, Swift, NodeJS, Haskell, Unreal, Unity, Lua and JavaScript.

Remember, you will only have a limited amount of time, so it is inadvisable to attempt to learn a new language while completing the project. It is better to use one you have learned or been taught before commencing this work.

Rather than attempting a project that is too simplistic, take on a challenge instead. It is acceptable not to complete every aspect of the work, providing it is written up well.

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TOP TIP

## Getting the scope right

Students must choose their own project. You cannot ask your teacher for ideas, although they can help you select from a list you have made. Theoretically, it could be a large group project with each student contributing a significant part, but this is unlikely to be successful and not recommended.

Your choice of program for your project is one of the most important choices you will make. The size of the problem you undertake is known as its "scope". Some features will fall within the scope; others, outside it. Essentially, you can solve almost any problem you wish, but you need to get the scope right. Too little scope and the project becomes trivial; too much, and it becomes unachievable. Your teacher can help you scope the project once you present them with an idea. It is usually possible to take simple ideas and expand them through a series of iterations to arrive at an appropriate scope.

Many of the best projects manipulate data. Stock control systems, booking systems, expert systems, revision tools and simulations all make use of data sets. Programs that create, read, edit, write and delete data - especially from files - usually have a good scope.

Robotics projects and programs that interface with hardware such as sensors are likely to require the use of APIs or hardware-specific functions and can make excellent computer science projects. Using Raspberry Pi or Arduino computers can provide for interesting projects, providing you can write plenty of original code and not use drag-and-drop script builders. Raspberry Pi uses Python (that's what the Pi means), and Arduino uses C, so both are approved.

Networking projects can also be extremely fun, making use of interaction across a network. Simple retro 2D computer games from a bygone age also make great projects: Space invaders, Pac Man, Minesweeper etc. Research 1980s arcade / C64 / Spectrum games to get some ideas.

A game of noughts and crosses where a player simply chooses a grid position to place their mark is more like a GCSE project - in other words, not complex enough. However, including an algorithm that demonstrates machine learning such as MENACE (Machine Educable Noughts and Crosses Engine) would turn this into a great A Level project. A simple game of battleships where the computer opponent chooses a random square to fire at is simplistic. An algorithm that decides the next position to fire on after a hit is scored and is dependent on the shape of ships already shot down has that added layer of complexity that would elevate the project to A Level standard.

A game of Pong with two paddles and a ball is too simplistic. Extending this to a breakout clone with bricks and power-ups adds the required complexity. Extending this further into a four-player version where players defend their castle in the four corners of the screen like the classic Atari game *Warlords* would be fantastic. It is usually possible to take a simple idea and, through a series of extensions, arrive at a game with sufficient complexity.

Be careful of games that look straightforward but are quite difficult to achieve without a good game engine. Platform and racing games can often fall into this category.

## Helping to scope a video game project

Easier to implement		Harder to implement
Single screen - e.g., <i>Space Invaders</i> , <i>Pac-Man</i>	Multiple single screens - e.g., <i>Bomb Jack</i> , <i>Bubble Bobble</i>	Fully scrolling with camera - e.g., <i>Super Mario</i> , <i>Gauntlet</i>
One type of enemy	A few different enemies	Lots of different enemies
No enemy AI - e.g., <i>Space Invaders</i>	Simple enemy AI - e.g., <i>Pac-Man</i>	Intelligent enemy AI - e.g., <i>Killzone</i>
Single life	Multiple lives or health	Combination of health and lives
No animations - e.g., static images, player's ship in <i>Space Invaders</i>	Changing images - e.g., movement sprites walking left and right	Physics objects - e.g., rolling dice tumbling in 3D
A single level	A couple of levels	Multiple levels with a boss fight
Levels with no platforms/walls	Levels with horizontal platforms and vertical walls	Angled or moving platforms
Two-player	Single-player with bots	Networked multiplayer
Static background	Moving background	Parallax scrolling
Horizontal/vertical movement and single-direction firing	Eight-way movement and firing	Full rotational movement and firing
No changeable settings	Simple settings - e.g., volume control	Advanced settings - e.g., changing difficulty level
All data is stored within the project	Use of external modules to build data or function libraries	Use of JSON to load and store external data
Simple sound effects	Conditional sound effects	Dynamic sound

## Questions to think about

- Is it easy for me to research the problem?
- Does my project include substantial algorithms?
- Will my project require me to use arrays, lists or other data structures beyond variables?
- Does my project use external data sets that must be searched or stored in a database management system (DBMS), serial, CSV, XML or JSON?
- Do I have enough experience using the language I intend to use?
- Will I be able to complete the work independently without asking for help?

Before you embark on your project, you need to have had plenty of practice solving problems and writing algorithms. Although the coursework is only worth 20% of your final grade, it is a significant undertaking that will require a lot of your time.

Writing code is fun, but it is only worth 15 out of the 70 marks available. Being good at programming helps a lot, but it does not guarantee success – a good write-up does!

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TOP TIP

## Stakeholders

In the past, it was a requirement that computer science projects had a real user with a real-world problem that you were attempting to solve. Those were the days when there were few off-the-shelf and online apps, so bespoke solutions were the norm. Today, A Level projects do not require you to have a single, identified user who needs your program. Instead, you will need to identify stakeholders; a target audience who would have an interest in using your product.

That said, it is extremely useful to have at least one person who can represent your stakeholders with whom you have regular contact. For example, if you were writing a chemistry revision program for 15-year olds, it would be useful to talk to both a chemistry teacher and a 15-year-old chemistry student.

Your stakeholders will be able to provide you with additional success criteria at the analysis stage, insights at the design stage, feedback during development and an evaluation at the end. Not having suitable stakeholders will severely limit your discussion, resulting in a weak project.

## Programming paradigms

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You may choose any programming paradigm that your chosen language supports, including procedural, object-oriented or functional. There is no requirement to use object-oriented techniques. It is a misconception that OOP provides substantial algorithms; however, it often makes coding simpler and usually indicates that a project has sufficient scope.

There may be language-specific techniques you can make use of to increase functionality, including external libraries. For example, the program must have a graphical user interface, so if you are planning to use Python, you may want to use Tkinter to provide this functionality.

There is no need to reinvent the wheel unnecessarily. If the language supports built-in algorithms and data structures, you should make use of them. Why write a sorting algorithm in Java when it already provides a Tim sort, which is extremely efficient? You will gain credit for using appropriate features.

## Working on your project

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It is sensible to structure your work into the four sections that match the mark scheme outlined in this guide, although evidence to support assessment can be found anywhere within your submission. For example, if you include something in the design that should, strictly speaking, be included in the analysis, you will not be penalised. The sub-sections in this guide provide you with a handy explanation of how marks are awarded, but you should use your own sub-headings.

You are permitted to work on your project outside of lesson time, including for homework. However, your teacher will need to authenticate your work as your own, so they will want to see a significant proportion being completed in class too.

Your project report should be a word-processed document with a suitable cover page, including your name, candidate number, centre name and centre number. Ensure each page is numbered so your teacher can cross-reference when marking. You must also include a bibliography or page of references. There is no requirement to adhere to a specific referencing standard.



### Examiner's advice

*"The best projects tend to be more ambitious. A project that a candidate can complete without encountering any challenges will give them little to write about. A candidate can still receive high marks for an ambitious project that does not achieve all its aims."*

## An initial proposal

Before embarking on your project, it is a good idea to submit an initial proposal to your teacher; this will enable them to assess the scope and complexity of your project before you do too much work.

It is important to choose a project you will be interested in developing; this is a substantial piece of work – you need to enjoy it!

Your project proposal should include:

- A title.
- A brief overview of your idea.
- An outline of what you want to achieve as an outcome.

You do not need to submit your proposal in your final project. However, your teacher may decide to submit it to the examination board before you seek their guidance on scope, complexity and viability.

## The role of your teacher

The Joint Council for Qualifications sets rigorous expectations on the completion of internally assessed work and clear guidelines for the role of the teachers assisting you.

Teachers **are** permitted to:

- Support you in choosing an appropriate project without giving you a specific idea. For example, your teacher could advise and help you choose from a list of your own ideas.
- Provide you with the mark scheme.
- Review your work and provide oral and written feedback at a general level.
- Allow you to redraft your work in response to this feedback.

Teachers are **not** permitted to:

- Provide you with writing frames or paragraph/section headings.
- Provide detailed, specific advice on how to improve drafts to meet the assessment criteria.\*
- Give detailed feedback on errors and omissions.\*
- Intervene to improve the presentation or content of your work.\*
- Provisionally mark your work and then allow you to revise it.

*\*Unless they record the assistance and adjust marks accordingly.*