Subject-specific guidance

Overview

This section covers individual subjects' requirements for the extended essay (EE) in terms of:

- Choice of topic
- Treatment of topic
- Assessment:
    - Criterion A: focus and method
    - Criterion B: knowledge and understanding
    - Criterion C: critical thinking
    - Criterion D: presentation
    - Criterion E: engagement.

It assumes that teachers are already familiar with the EE generic guide and the EE teacher support material, in particular the process whereby students choose a subject area and topic, write their research question and select the research method(s) they will use to explore and answer it.

For a full summary, see the process diagram and the generic assessment criteria.

Or for a quick refresher, read Extended essay: general requirements .

General requirements

The EE is an in-depth study of a focused topic. It gives students the opportunity to:

- engage in independent research with intellectual initiative, creativity and rigour
- develop research, thinking, self-management and communication skills
- reflect on what they have learned throughout the research and writing process.

All students must:

- provide a logical and coherent rationale for their choice of topic
- review what has already been written about the topic
- formulate a clear research question
- offer a concrete description of the methods they use to investigate the question
- generate reasoned interpretations and conclusions based on their reading and independent research in order to answer the question.

Choice of topic

See also *Initial guidance on research and writing*

Students first need to identify the broad area of inquiry they are interested in.

Sources of ideas may include:

- work already undertaken as part of the course
- preliminary reading of academic journals and reputable scholarly e-resources, eg conference papers, essays, book chapters or journal articles. A school librarian can advise on this
- conversations with teachers, fellow students and librarians.

Literature review

Students should try to read as much as they can of what has already been written about their topic. Time spent on a literature review early on in the research process will guide and improve their work. It will help them to:

- contextualize their research question and subsequent findings
- meet criterion B: demonstrating knowledge and understanding .

While conducting their literature review, students may find it useful to compile an annotated bibliography and to record their responses to what they read in their researcher's reflection space (RRS).

If using the internet, students are encouraged to use specialized academic search engines that will find resources appropriate for citation in the EE.

Students must be aware of their responsibilities to cite properly the resources they use and to check their work for plagiarism. Their citations should adhere to the requirements of the IB and be consistently applied.

Research question

Students should identify a **working** research question early on but be prepared to change, eg if too little information is available to permit the intended investigation.

Students should be guided by the idea that what they are writing is important because:

- it seeks to fill a gap in understanding their chosen topic, or
- it offers a resolution to some controversial argument.

The research question should therefore be non-trivial and follow from the existing body of literature on the topic. It must be:

- specific, sharply focused and capable of being answered within a 4,000-word essay
- stated clearly in the introduction of the essay and on the title page
- related to the chosen topic.

Students need to avoid researching questions that are too narrow or too obvious as this will limit their ability to formulate reasoned arguments.

Their answer to the question must be analytical rather than descriptive.

Title

The title is a formal requirement on the title page of the essay. If the title is missing, it will be considered on balance with the other formal requirements against criterion D. While there is no explicit penalty in criterion A, the title will help address the requirements as it expands on the student's intended focus. Without a title, students lose an opportunity to clarify their focus.

Treatment of the topic

Once students have identified their topic and written their research question, they can decide how to research their answer. They may find it helpful to write a statement outlining their broad approach.

The definition of "research" and terms such as "primary data" and "secondary data" varies from subject to subject.

In some subjects, students must use both primary and secondary data. In others, students may, or even must, rely exclusively on secondary data.

However, all students must carry out secondary research in terms of a literature review for their topic.

Two important reminders

1. Undertaking an extended essay is a challenge. Planning is crucial. Students need to start writing their papers early and discuss any emerging difficulties with their supervisor. As well as their supervisors, librarians are a great source of information, advice and support for students.
2. Students risk their diploma if found guilty of academic misconduct:

The sciences

An overview of writing an extended essay in the sciences, see The sciences: An introduction.

Environmental systems and societies guidance is in the interdisciplinary essays section.

Computer science: Subject-specific guidance

See also: EE generic guide and EE teacher support material

Overview

An extended essay (EE) in computer science provides students with an opportunity to investigate a particular aspect of computing and its implications for society and the world.

Within this context, they can research the latest developments and future possibilities in a rapidly changing subject that is continually breaking new barriers. There are many possible areas to be explored, each with a wealth of topics: advances in hardware and software development, comparison of the efficiency of algorithms designed to speed up data transmission or to encrypt data, network systems, computer control systems and so on.

Choice of topic

It is important that the chosen topic and its treatment reflect a firm emphasis on computing science and explores beneath the surface of this subject.

It is also important that the work goes beyond a summary of journalistic views on a particular topic. It is not sufficient for the student simply to describe new advances and developments in computing. Students are expected to analyse their findings and consider the implications.

Often, the ethical and social effects of the topic chosen will be important and may well have a part within the essay, for example in the conclusion. However, an essay that makes these considerations a major focus is not appropriate and would be better submitted as an information technology in a global society (ITGS) essay.

An in-depth analysis of trends and advances in computing should include aspects of the theory of computer science, which would necessarily demonstrate a high degree of technical knowledge and understanding.

Data for analysis may be generated from a program written by the student. This is often an appropriate method of investigation, but the code itself, and its development, will not be rewarded under the assessment criteria unless the specific techniques employed are of particular relevance to the research question.

The EE is not in any way to be confused with the computer science project that is completed as the internal assessment component for the computer science course. If the data analysed is not directly related to computer science, the EE should be registered in another, more relevant, subject.

The chosen topic may be inspired by a magazine article, an internet site, one of the case studies published in connection with computer science HL paper 3 examinations, a conversation or simply an idea that could fall into one of the following areas of interest:

- aspects of the current computer science syllabus that are taken to a far greater depth than that provided in the course
- current aspects of computing that are set to change or be challenged in the near future
- future developments that are currently experimental but beginning to look possible
- solutions to limitations that are evident in current hardware or software
- comparisons between different computer systems that are actually in place.

The topic chosen should allow the student to make a full appropriate analysis, putting forward his or her own point of view.

Historical aspects of computing do not lend themselves to this treatment.

However, there may sometimes be a place for summarizing developments that have occurred until now, to put the topic in perspective or to use as a basis for predicting the future.

Availability of resources should be a consideration when deciding on a topic. The student should not choose to investigate a complex computing topic for which they have little or no access to appropriate background material or resources.

Examples of topics

These examples are just for guidance. Students must ensure their choice of topic is focused (left-hand column) rather than broad (right-hand column).

 Focused topics	 Broad topics
A comparison of overclocking and pipelining in terms of efficiency in enhancing the performance of CMOS processors	Factors that affect processor speeds
Advances in processing power that question the need for complicated sorting algorithms	The future of sorting algorithms
Assessing the level of data compression in music files that is acceptable to the human ear	Data compression techniques
An evaluation of secure sockets layer (SSL) protocol	Internet security

It may help for the student to start with a broad topic or area of interest, then undertake some initial secondary research before refining their topic into a more focused area and developing a preliminary research question.

Additionally, adding a statement of intent that indicates which broad process is going to be used in answering the question will help to ensure students remain focused on their research question.

Treatment of the topic

An EE in computer science is not intended as a vehicle to demonstrate programming skills. These are demonstrated in the computer science project (the internal assessment requirement of the computer science course).

The EE is an opportunity for students to be creative in a different sphere—that of independent, personal research.

While an EE may refer to a programming exercise, such as a compiler for a new language designed by the student, the emphasis in such a case should be on the design, development and analysis of the compiler and on language design. Some evaluation of the compiler in relation to those already existing is also expected.

Although program fragments may be included in the body of the EE to support the design and the discussion, the full program code (including internal documentation) should appear in an appendix as evidence.

Futuristic topics in computer science should be based on sound theory and projections of well-known computer science authorities.

Students are expected to support personal conclusions with the theories presented. This is an area where students need to be particularly careful that the analysis they apply to information gathered is their own independent analysis and that the information they use is from reliable sources.

Students are likely to turn to the internet for sources of information. When doing so, they need to verify the reliability of sources and also ensure that they are not relying too heavily on these sources to collate, rather than analyse, information.

Students are expected to both critically evaluate the resources consulted during the process of writing the essay and to expand on the material gathered from these sources in order to make any technical information understandable to a reader who might not be a specialist in the subject.

Frequent reference to the assessment criteria by both the supervisor and the student will help keep a sharper focus on the project.

Examples of topics, research questions and suggested approaches

Once students have identified their topic and written their research question, they can decide how to research their answer. They may find it helpful to write a statement outlining their broad approach. These examples are for guidance only.

Topic	**Advances in machine learning: the effectiveness of reinforcement learning in turn-based strategy games**
Research question	How effective is reinforcement learning for improving performance in turn-based strategy games?

Approach	A practical investigation involving the comparison of the success of different algorithms in the playing of the Connect-4 game.

Topic	**The feasibility of wireless networking in a city-wide context**
Research question	To what extent is wireless networking a feasible alternative to cabled networking within a whole-city context?
Approach	A feasibility study of the hardware and communications needed to set up a city-wide network in wireless and cabled systems.

Topic	**Advances in computer processing**
Research question	How likely is it that fuzzy logic will replace binary logic in the next five years?
Approach	An investigation into the current state of implementation of multi-state logic and the differences between this and binary state logic.

An important note on "double-dipping"

Students must ensure that their EE does not duplicate other work they are submitting for the Diploma Programme.

The computer science EE and internal assessment

In particular, an EE in computer science is not an extension of the internal assessment (IA) task. Students must ensure that they understand the differences between the two.

- Students are not permitted to use any of the data generated as part of their computer science solution (IA) for the EE.
- Whereas the IA may focus on any aspect of computer science, an EE must not primarily be concerned with designing computer programs, although an evaluation of an existing program is permitted.

Supervisors play an important role in guiding students on these distinctions. Students risk their diploma if academic misconduct is detected.

Interpreting the EE assessment criteria

Criterion A: Focus and method

(Strands: Topic, Research question, Methodology)

The title should clearly indicate the area of research, with the underlying computer science forming the principle basis of the essay.

Students should avoid topics that deal primarily with social aspects of information technology that would lie more within the subject ITGS (eg "The value of friendships attained through social networking sites").

The research question must be sharply focused in order to allow for significant research into the topic at an appropriate depth. At the same time the topic must be accessible to an IB student.