DP Country Alignment Studies: Alignment of the Finnish National Core Curriculum (FNCC) for General Upper Secondary Education (GUSE)

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Acronyms

AA	mathematics: analysis and approaches
AHL	additional higher level
AI	mathematics: applications and interpretation
ATL	approaches to teaching and learning
CP	Career-related Programme
CAS	creativity, activity, service
DP	Diploma Programme
FNCC	Finnish National Core Curriculum
GUSE	General upper secondary education
HL	higher level
IB	International Baccalaureate
IBO	International Baccalaureate Organisation
MYP	Middle Years Programme
NCC	National Core Curriculum
PYP	Primary Years Programme
RfP	Request for Proposal
RQ	Research Question
SL	standard level
STEM	Science, technology, engineering and mathematics
TOK	theory of knowledge
USA	United States of America
WIAIBE	What is an IB education?

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1. Executive Summary

Project Aims and Context

The International Baccalaureate (IB) Organization is a not-for-profit educational foundation offering four programmes across the world. One of them – the Diploma Programme (DP) – is a two-year upper secondary programme, primarily intended to prepare students for university matriculation and higher education.

Ecctis was commissioned by the IB to deliver a series of in-depth studies to assess the level of alignment between the DP and comparison points within the upper secondary education systems of Australia, Canada, the United States of America (USA), Singapore, South Korea, and Finland. More specifically, the studies aim to identify areas of similarities and differences between the DP and these educational systems to inform the IB's development of tools and resources for IB teachers, ultimately helping them navigate between the DP and the local curriculum in the target countries. In doing so, the studies also contribute to further supporting fair recognition of the DP by institutions, employers, and other key stakeholders, supporting progression and mobility for DP holders. The studies include, for all countries, a focus on mathematics and the sciences, with an additional focus on history for Australia, and English for the USA.

This report aims to specifically evaluate alignment between the DP and the upper-secondary programme of education in Finland. The comparison curriculum in question is the Finnish National Core Curriculum (FNCC), taught as part of the General Upper Secondary Education programme (GUSE). Since the FNCC (i.e. the curriculum) describes aspects of the GUSE (i.e. the programme), both are referred to in the analysis at programme level, while at subject level the main reference point is the FNCC.

Research Questions and Methods

All comparative studies in this series have been framed by responses to Research Questions (RQs), both at programme and subject levels. For this study, these RQs were the following:

RQ1: To what degree does the DP curriculum align with the Finnish upper secondary curriculum? In what way are the curricula similar and in what way are they different in demand and difficulty? To what degree are the curricula compatible?

RQ2: To what degree do the curricula align with regard to their:

2.1: Philosophical underpinnings
- Objectives
- Principles
- Values.

2.2: Structure
- Learning areas
- Subject offerings
- Degree of specialization
- Time allocation.

2.3: Requirements

- Programme entry requirements
- Time requirements (i.e. programme duration, teaching hours, study hours)
- Certificate requirements (i.e. credits, passing and failing conditions, compensation options).

2.4: Assessment

- Nature of assessment (i.e. number, type, duration, question types, availability of marks)
- Assessment model (i.e. relative weighting of assessments to overall grades).

2.5: Student learning pathways

- Degree of specialization
- Options in subject (area) choice (i.e. compulsory subjects, electives).

RQ3: To what degree do the subjects align with regard to:

3.1: Content

- Topics (i.e. scope of content area, breadth, depth)
- Learning activities (i.e. difficulty, demand).

3.2: Expected learning outcomes

- Knowledge
- Competencies (i.e. subject-specific, 21st century competencies).

To answer the above RQs, Ecctis developed and applied a bespoke methodology.

At programme-level, this involved the comparative analysis of key components of the DP and the FNCC/GUSE, including: philosophical underpinnings, structure, requirements and associated outcomes, student learning pathways, and assessment methods (where possible). At subject-level, it involved the comparative analysis of key components of the DP and FNCC subjects, including: learning outcomes, content, and demand.

Where appropriate, Ecctis complemented its standard comparative methodology with a comprehensive mapping method, extracting themes from the DP to evaluate their presence in the comparison point(s). Additionally, to assess demand at subject level, Ecctis designed and deployed an expert panel approach, scoring each individual subject against a common set of demand criteria.[1]

Key Findings

Programme-level

The structures of the two programmes are the most significant point of difference and the philosophical underpinnings are the most significant point of similarity. In all other respects, there are some notable differences, though with points of clear alignment with regard to how students would be likely to experience the programmes in practice. Key similarities and differences include:

- **Philosophical underpinnings**: all the key themes within the IB's learner profile, approaches to teaching and learning (ATL), and philosophy of international-mindedness are strongly present in the transversal competencies of the FNCC.

[1] Each individual subject was scored for: cognitive skills evidenced in the learning outcomes (based on the Revised Bloom's Taxonomy), depth of knowledge (adapted from Webb's Depth of Knowledge levels), volume of work (a tri-factor score considering breadth, depth and allocated timeframe), and outstanding areas of subject demand (stretch areas).

Although there are some differences in the degree of emphasis on specific issues – namely technology and national identity, which are more predominant in the FNCC – students or teachers moving between these programmes would find a high level of consistency between the philosophical underpinnings.

- **Programme structure**: both programmes take a baccalaureate-style approach to encourage breadth of study; require students to study subjects from broadly similar subject areas; and allow them to specialise in particular subjects. However, there are also significant structural dissimilarities between both programmes. While the FNCC is studied over three years, the DP is studied over two. Moreover, the FNCC/GUSE's 150-credit structure leads to a larger number of subjects being experienced by students, whereas the DP's six-subject structure leads to a smaller number of subjects. Additionally, the FNCC does not include elements similar to the DP's theory of knowledge (TOK), creativity, activity, service (CAS), and the extended essay. Instead, the FNCC provides students with the option to study additional subjects (known as general upper secondary diplomas) which are focused on assessing student's competence and independent interest in subject areas that are not included in the DP (e.g. home economics, crafts, media).

- **Entry requirements**: both the DP and the FNCC/GUSE present flexible approaches to entry requirements at the start of their programmes. The IB encourages students and teachers to consult subject guides around expected prior learning but does not provide fixed entry requirements. There are also no fixed entry requirements to study the FNCC/GUSE in Finland; whilst the key criterion for admission is that the student has completed the comprehensive school syllabus, any student with an equivalent completed syllabus and sufficient potential is eligible to apply. Nevertheless, each education provider may issue additional selection criteria, such as entrance exams, so the specific requirements may vary per school.

- **Student learning pathways**: both programmes provide a significant level of optionality in relation to subjects studied and both require students to study subjects from a wide range of subject groupings. The approach to combining subject-specialisation with breadth is therefore fairly similar; however, the structural dissimilarities mean that the practical nature of student pathways are inevitably quite different. The same student looking at both programmes would have to make fairly different practical choices to achieve the specific subject balances required by each diploma, but both would enable that student to pursue subjects that interest them to a higher level than subjects that are less significant to their intended pathway.

- **Assessment methods**: whereas the DP uses external terminal assessment to make up the majority of assessment in each individual subject, the FNCC/GUSE uses flexible internal assessment to comprise the full weighting of assessment in all subjects. However, the flexibility of the internal assessment in the FNCC could result in a practical student experience that is quite similar in some respects to the DP's assessment patterns. For instance, the type of skills assessed in each programme and the types of assessment used appear to be broadly aligned.

Subject-level

In this study, Ecctis carried out subject-level comparative analysis between the DP and the FNCC in mathematics, physics, chemistry and biology, focusing on the following DP standard level (SL) and higher level (HL) subjects and comparison subjects:

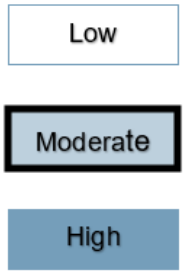
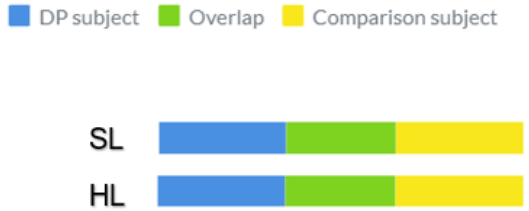
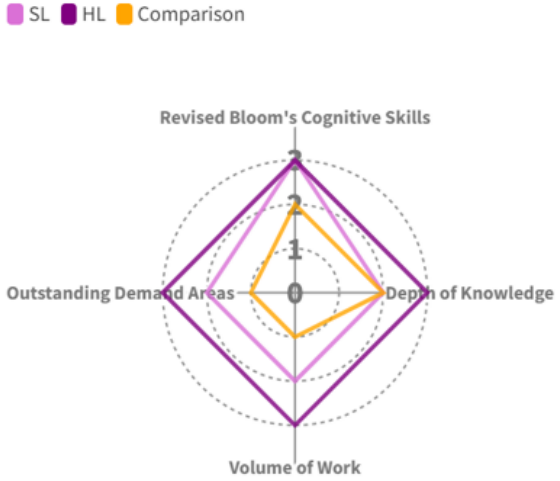
Table: Subject areas for comparison of the DP and the FNCC/GUSE subjects

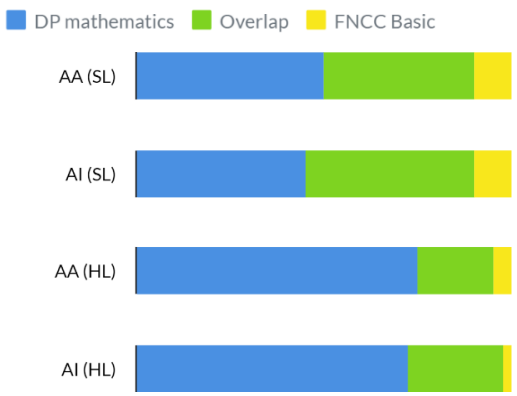
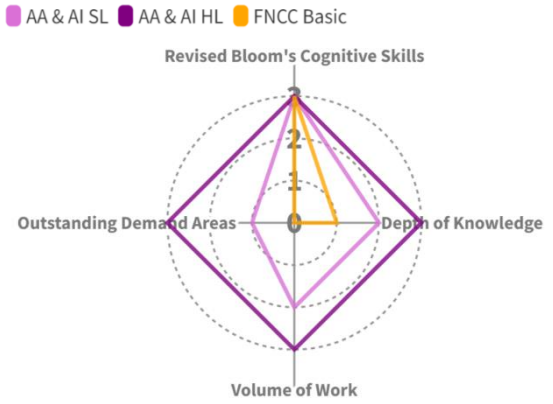
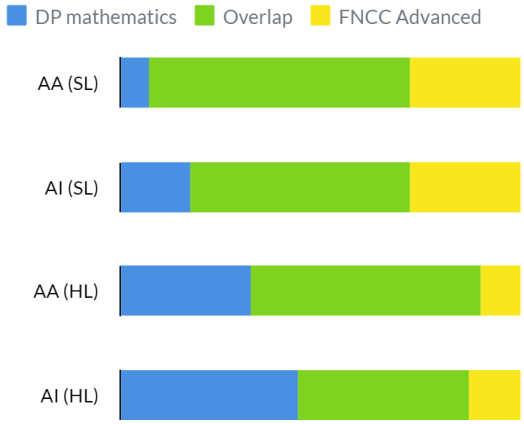
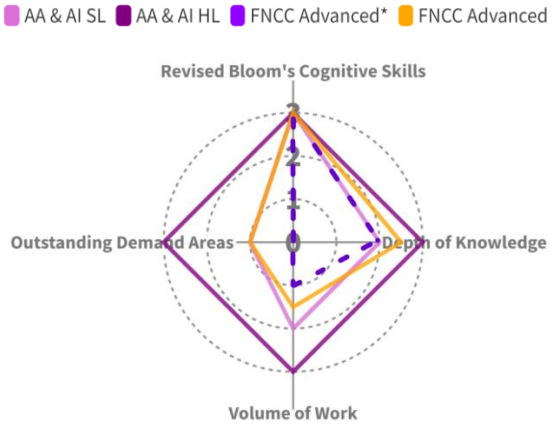
DP subject (group)	**Finland subjects**
SCIENCES	
biology SL and HL	biology
chemistry SL and HL	chemistry
physics SL and HL	physics
MATHEMATICS	
mathematics: analysis and approaches (AA) SL and HL	basic mathematics advanced mathematics
mathematics: applications and interpretation (AI) SL and HL	

The findings from the subject-level analysis are summarised in the tables below:

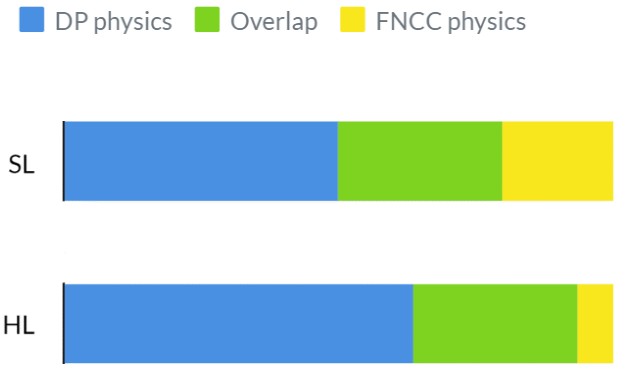
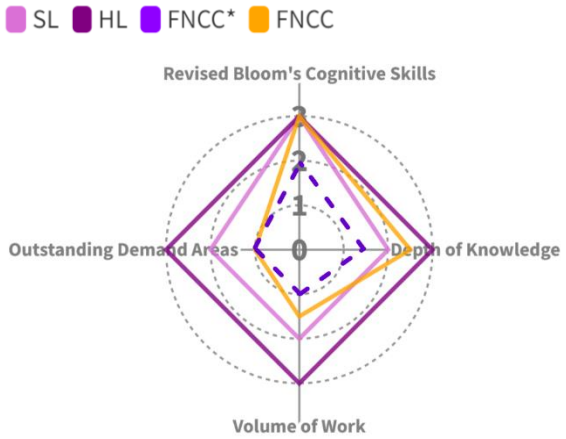
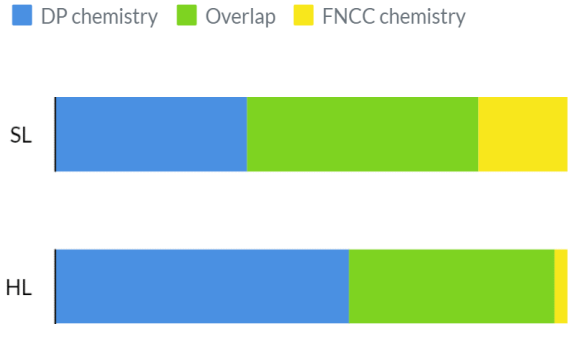
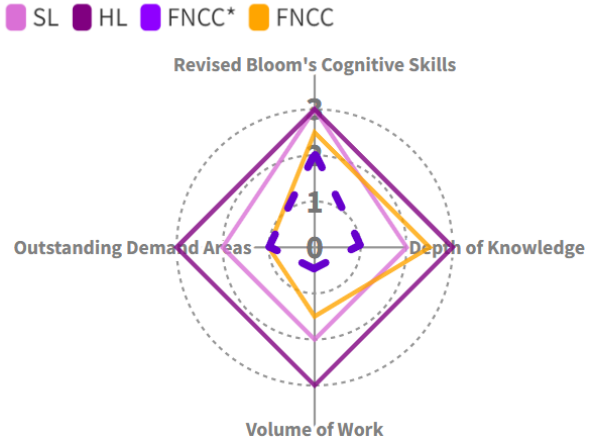
Figures: Visual representation of alignment between DP subjects and comparison subjects

Key:

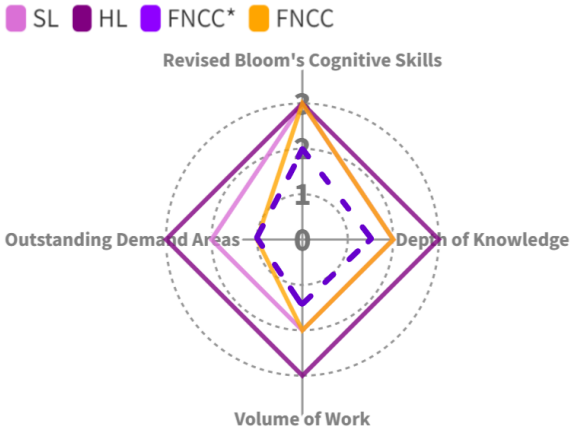
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Displays the name of the comparison subject	 This represents the learning outcome alignment between the DP subject and the comparison subject. A black border is placed around the selected judgement – 'Moderate' in this example.	 These bars represent the content alignment between the DP subject and the comparison. There is one bar showing alignment with SL content and another for HL content (inclusive of SL content). The **green** section of the bar represents the overlap of content between the subjects. The **blue** section represents content which was in the DP subject only. The **yellow** section represents content which was in the comparison subject only. Therefore, if, say, the blue section was longer than the yellow, this can be interpreted as the DP subject having more content unique to itself than the comparison did. A large green bar would indicate that a substantial proportion of content is common to both the DP and comparison subject.	 This radar diagram displays the demand judgement scores for the comparison subject(s) and the DP subject – both SL and HL.

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Basic syllabus (mathematics)	Low Moderate **High**		
Advanced syllabus (mathematics)	Low Moderate **High**		

NB: For demand, the subjects signalled with a '*' represent the compulsory modules only, as opposed to the full FNCC syllabus (i.e. both compulsory and additional optional modules combined).

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Physics	Low Moderate **High**		
Chemistry	Low Moderate **High**		

NB: For demand, the subjects signalled with a '*' represent the compulsory modules only, as opposed to the full FNCC syllabus (i.e. both compulsory and additional optional modules combined).

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Biology	Low Moderate High		

NB: For demand, the subjects signalled with a '*' represent the compulsory modules only, as opposed to the full FNCC syllabus (i.e. both compulsory and additional optional modules combined).

As well as alignment judgements, the analysis also uncovered various similarities and differences between the DP and comparison subjects. Key highlights are summarised below. Notably, the exact depth of the FNCC subjects' content is not possible to ascertain from the curriculum documentation, as each education provider prepares their own local curriculum based on the FNCC. Thus, while the analysis in this report is based on the FNCC documentation, the way in which the latter is implemented locally may vary significantly depending on the education provider.

Mathematics

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the FNCC syllabi learning outcomes is significant, as all DP themes are present in the FNCC.

- **Content alignment**: though the FNCC's basic syllabus has some overlapping content with DP SL, the latter surpasses it in breadth and depth. The FNCC's advanced syllabus is slightly more aligned with AA than AI, for both SL and HL. There is a reasonable amount of alignment with DP AA HL; however, based on the documented content (which may be further developed by each provider), the advanced syllabus has less breadth and depth of content than both the DP AA HL and AI HL. Notably, students in the FNCC are not required to take optional modules and in practice may study a somewhat smaller volume of content. Without the optional modules, the breadth and depth of the advanced syllabus are more comparable to those of the DP SL.

- **Demand alignment**: the FNCC basic syllabus is the least aligned with DP subjects in terms of demand, scoring less than DP SL for all categories except Bloom's cognitive skills. The advanced syllabus is more similar in demand to DP SL than DP HL, becoming more strongly aligned when all modules are studied, both compulsory and optional. All FNCC courses scored lower than the DP subjects for volume of work – though the lack of detail in FNCC documentation, with regard to depth of content, is a factor here.

Physics, chemistry, and biology

All DP science subjects – physics, chemistry and biology – have been individually analysed and compared against the designated comparison subject. However, as they share a number of similarities – for instance, the same learning outcomes, assessment objectives and assessment requirements – the findings for all courses were similar and are, thus, collectively presented below.

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and FNCC physics, chemistry and biology subjects is significant, with all themes extracted from the DP learning outcomes being present in the FNCC's learning outcomes.

- **Content alignment**: there is some topic and sub-topic overlap between the DP and the FNCC science subjects, for both SL and HL, with stronger alignment observed in chemistry and biology than in physics. All FNCC science comparison subjects contain

a mixture of SL topics and HL topics, though the FNCC describes the content coverage of such topics in far lesser detail than the DP, resulting in many 'partial' rather than 'full' sub-topic alignments. This is true also for alignment with the DP's experimental programme, with the FNCC only including limited detail on practical experiments and scientific inquiry. Though there is evidence of a wide range of topics being touched upon in all three sciences, the documented size of the FNCC content is far smaller than DP HL and is seemingly surpassed in breadth and depth. The fact that only some SL and HL sub-topics are clearly included in the FNCC subjects results in relatively limited alignment with regard to content. Overall, the volume of content in the FNCC is surpassed by the DP HL subjects, which have greater breadth and depth (though it is possible that Finnish schools go beyond the documented content of the curriculum). Instead, FNCC physics, chemistry and biology's content appears to be of a similar size to that of the DP SL subjects, provided that both compulsory and optional modules are studied.

- **Demand alignment**: the demand of FNCC subjects varies depending on how many modules per subject are taken. When considering only the compulsory modules, the demand of FNCC subjects is lower than the DP at both SL and HL. When taking into account all modules (both compulsory and national optional modules), the FNCC physics, chemistry and biology subjects score comparably to DP SL. The DP physics, chemistry and biology subjects at HL surpass the demand level of the respective FNCC comparison subjects.

Summary

The programme-level features of the DP and the FNCC/GUSE are moderately aligned. The two programmes observe very similar philosophical underpinnings and share some similarities in their entry requirements and assessment objectives, though they differ in programme structure and student learning pathways. At subject-level, alignment between the FNCC and DP varies across subjects, being notably strongest when considering both the compulsory and optional modules in each FNCC subject, rather than just compulsory modules. For mathematics, alignment with the DP is strongest for the FNCC mathematics advanced syllabus, as opposed to the basic syllabus. As for science, the FNCC physics, chemistry and biology subjects were all considered to be moderately aligned with the respective DP subjects. Importantly, however, these subject-level alignments may increase depending on how the FNCC is implemented in the local curricula.

2. Introduction

2.1 Context and Scope

The International Baccalaureate (IB) Organization is a not-for-profit educational foundation offering four programmes across the world, including the Primary Years Programme (PYP), Middle Years Programme (MYP), Diploma Programme (DP) and the Career-related Programme (CP). The DP – the IB's two-year upper secondary Diploma Programme – is conceived as a preparatory programme for university matriculation and higher education, aimed at developing students with 'excellent breadth and depth of knowledge' who 'flourish physically, intellectually, emotionally and ethically'.[2]

Ecctis was commissioned by the IB to deliver a series of critical and in-depth alignment studies to assess the level of alignment between the DP and comparison points within the upper secondary education systems of Australia, Canada, the USA, Singapore, South Korea, and Finland.[3] More specifically, the studies aim to identify areas of similarities and differences between the DP and these educational systems by comparing philosophical underpinnings, structure, requirements, assessment methods, learning pathways, content, and specifically to determine how the DP compares to the selected benchmarks in terms of intended student learning outcomes at subject level. The studies include, for all countries, a focus on mathematics and the sciences, with an additional focus on history for Australia, and English for the USA.

Ultimately, this series of comparative studies aims to inform the IB's development of tools and resources for IB teachers, helping them navigate between the IB and the local curriculum in the target countries where needed. In doing so, it also contributes to further supporting fair recognition of the DP by institutions, employers, and other key stakeholders, supporting progression and mobility for DP graduates.

This report constitutes one of the project's deliverables and aims to specifically answer the research questions pertaining to how the DP aligns with the Finnish upper-secondary programme of education. As agreed with the IB, this report focuses specifically on the Finnish National Core Curriculum (FNCC) taught as part of the General Upper Secondary Education (GUSE) programme. Since the FNCC (i.e. the curriculum) describes aspects of the GUSE (i.e. the programme), both are referred to in the analysis at programme level, while at subject level the main reference point is the FNCC.

[2] International Baccalaureate. (2022). *Diploma Programme*. Available from: https://www.ibo.org/programmes/diploma-programme/

[3] The series of studies responds to the following Request for Proposals (RFP), issued by the IB: *The International Baccalaureate Diploma Programme: Alignment with Australian and Canadian Upper Secondary Education; Request for Proposals (RFP): The International Baccalaureate Diploma Programme: Alignment with the US Common Core State Standards (CCSS) and the New Generation Science Standards (NGSS); Request for Proposals (RFP): The International Baccalaureate Diploma Programme: Alignment with Singaporean, Korean and Finnish Upper Secondary Education.*

2.2 Research Questions

All comparative studies in this series have been framed by responses to Research Questions (RQs), both at programme level and subject level. For this study specifically, the RQs are as follows:

Finland Research Questions

Table 1: Finland research questions

RQ1: To what degree does the DP curriculum align with the Finnish upper secondary curriculum? In what way are the curricula similar and in what way are they different in demand and difficulty? To what degree are the curricula compatible?

RQ2: To what degree do the curricula align with regard to their:

2.1: Philosophical underpinnings
- Objectives
- Principles
- Values.

2.2: Structure
- Learning areas
- Subject offerings
- Degree of specialization
- Time allocation.

2.3: Requirements
- Programme entry requirements
- Time requirements (i.e. programme duration, teaching hours, study hours)
- Certificate requirements (i.e. credits, passing and failing conditions, compensation options).

2.4: Assessment
- Nature of assessment (i.e. number, type, duration, question types, availability of marks)
- Assessment model (i.e. relative weighting of assessments to overall grades).

2.5: Student learning pathways
- Degree of specialization
- Options in subject (area) choice (i.e. compulsory subjects, electives).

RQ3: To what degree do the subjects[4] align with regard to:

3.1: Content
- Topics (i.e. scope of content area, breadth, depth)
- Learning activities (i.e. difficulty, demand).

3.2: Expected learning outcomes
- Knowledge
- Competencies (i.e. subject-specific, 21st century competencies).

With regard to subjects to be compared in the subject-level comparative analysis, the following table indicates the agreed scope:

Table 2: Subject areas for comparison of the DP and the FNCC

DP subject (group)	Finland subjects
SCIENCES	
biology SL and HL	biology

[4] With regard to subjects within scope, see Table below.

chemistry SL and HL	chemistry
physics SL and HL	physics
MATHEMATICS	
mathematics: analysis and approaches SL and HL	basic mathematics advanced mathematics
mathematics: applications and interpretation SL and HL	

All DP curricula has been considered at both standard level (SL) and higher level (HL).

2.3 Report Structure

In responding to the above RQs, this report included the following sections:

- 3. Methodology: this section provides a brief overview of the methodology applied in this study. This includes details of how the document selection and identification of comparison points for the study took place; a definition of 'alignment'; an outline of the methodology used for comparisons at both programme and subject levels; and an outline of the methodology used to assess demand.

- 4. Programme-Level Alignment: this section presents the synthesised analysis from the programme-level comparisons between the DP and the Finnish general upper secondary programme. In doing so, it includes brief programme overviews for both qualifications, followed by the comparative analysis on their philosophical underpinnings, structure, requirements and associated outcomes, student learning pathways and the general nature of assessment practices.

- 5. Subject-Level Alignment: this section presents the synthesised analysis from the subject-level comparisons between DP and Finnish upper secondary curriculum subjects. For each comparison subject, this includes the comparative analysis on their learning outcomes, content, and demand.

- 6. Key Findings: this section outlines the key findings from both the programme- and subject-level comparisons undertaken in this study. In doing so, it provides a top-level conclusion on alignment at both programme and subject levels, and a succinct summary of key similarities and key differences.

- 7. Bibliography: this section references all sources cited in the study, including the documents used for both programme- and subject-level curriculum analyses.

3. Methodology

3.1 Document Selection and Identification of Comparison Points

To undertake these comparative analyses, the following core documentation was reviewed (supplemented by additional documentation – detailed in the Bibliography – where relevant and available):

IB Documentation

- What is an IB education? (WIAIBE)
- WIAIBE Teacher Support Material
- DP: From Principles into Practice
- Programme Standards and Practices
- DP subject guides:
    - mathematics: analysis and approaches
    - mathematics: applications and interpretation
    - biology
    - chemistry
    - physics.

Finland Documentation

- Finnish National Agency for Education – *National Core Curriculum for General Upper Secondary Education,*[5] which includes:
    - Information about underpinning philosophy and pedagogy; and
    - The Finnish Curriculum – General Upper Secondary Subject Syllabi:
        - physics
        - chemistry
        - biology
        - mathematics (basic and advanced).

Philosophical Underpinnings Comparison

For the programme-level comparisons between the philosophical underpinnings of each programme, Ecctis used the following elements of the curriculum documentation:

[5] Finnish National Agency for Education. (2019). *National Core Curriculum for General Upper Secondary Education*.

Table 3: Philosophical underpinnings for comparison of the DP and the FNCC

Documentation containing philosophical underpinnings	
DP	**Finland**
'What is an IB Education', particularly the following sections: ○ IB learner profile ○ International-mindedness ○ Approaches to teaching and approaches to learning (ATL)[6]	'transversal competences' within the National Core Curriculum for General Upper Secondary Education[7]

The document 'What is an IB Education?' provides detailed information about the IB's educational philosophy. For Finland, the philosophy and pedagogy of the FNCC are articulated in the 'transversal competences' section of the National Core Curriculum for General Upper Secondary Education document.

For more information on the mapping process, see the Measuring Alignment section below.

Learning Outcomes Comparison

For the Learning Outcomes comparisons, as neither of the two qualifications explicitly defines 'learning outcomes' in their curriculum documentation, Ecctis used the following categories of the curriculum documentation for comparison:

Table 4: Learning outcomes for comparison of the DP and the FNCC

DP subject (group)	**Categories utilised as learning outcomes**
SCIENCES	
biology	DP sciences subject group – aims and assessment objectives
chemistry	
physics	
MATHEMATICS	
mathematics: analysis and approaches	DP mathematics subject group – aims and assessment objectives
mathematics: applications and interpretation	
Finland subjects	**Documentation and Sections**
SCIENCES	
biology	task of the subject transversal competences general objectives
chemistry	task of the subject transversal competences general objectives
physics	task of the subject transversal competences general objectives
MATHEMATICS	
basic mathematics advanced mathematics	task of the subject transversal competences general objectives

[6] International Baccalaureate. (2017). *What is an IB Education?*

[7] Finnish National Agency for Education. (2019). *National Core Curriculum for General Upper Secondary Education.* p. 70.

Although not labelled as learning outcomes per se, the above categories were chosen as they were deemed to provide the most complete picture of the skills and knowledge that students should obtain upon completion of each subject.

For more information on the mapping process, see the Measuring Alignment section below.

3.2 Measuring Alignment (Similarities and Differences)

Alignment is a key concept for this series of studies. The aim of this study is to unpick the level of alignment between the DP and the FNCC/GUSE. Although Ecctis has sought to represent the alignment findings as straightforwardly as possible in this report, alignment is not a simple concept, so it is important to establish Ecctis' approach in this regard.

Alignment, as a term, is often used in education circles to refer to *internal* coherence between learning outcomes, assessment methods, teaching practices and other features of teaching and learning. This report does not consider *internal* alignment, but what might appropriately be labelled *external* alignment. Alignment of this type looks at the extent to which a programme (in this case, the DP) aligns with other educational programmes (in this case, the FNCC/GUSE). This form of external alignment is particularly key to understand for an organisation like the IB which operates in so many international contexts, often alongside national curricula, where teachers and students may seek to move back and forth between IB and national streams of education.

Within this narrower definition of *external* alignment, the idea is still broad and could be seen from any number of perspectives. In this series of studies, the IB has specifically asked Ecctis to consider alignment from the specific perspectives outlined by the RQs. The RQs thereby define the limits of the type of alignment that will be considered within the reports. Namely:

- At the programme level:
    - Alignment of philosophical underpinnings
    - Alignment of structure
    - Alignment of requirements and associated outcomes
    - Alignment of student learning pathways
    - Alignment of approaches to assessment.

- At the subject level (in selected subjects):
    - Alignment of learning outcomes
    - Alignment of content
    - Alignment of demand.

To form a comprehensive picture of alignment, Ecctis' approach has used multiple repeating steps within each report. For Finland, it sought to:

- Analyse to what extent the FNCC/GUSE has similarities with the DP.
- Analyse to what extent the FNCC/GUSE lacks features contained within the DP.
- Analyse to what extent the DP lacks features contained within the FNCC/GUSE.

In this respect, **alignment is a measure of the extent to which there are similarities and differences between key selected criteria of two educational programmes**. High alignment indicates significant similarities, with few differences in key areas, whereas low alignment results from many differences in important aspects, with perhaps only few or non-impactful similarities. Alignment judgements in this study took a holistic view of similarities and differences and the likely impact these will have on what skills and knowledge students possess upon completion of a programme of study. As such, the study did not use fixed quantitative criteria to differentiate high from low alignment, but rather produced informed, holistic judgements drawing on an outcomes-focused perspective.

Mapping

To accurately measure the alignment of the DP to the FNCC/GUSE, it is necessary to map the similarities and differences across the selected alignment criteria. This necessitates identification of the same structural features in the DP and in the FNCC/GUSE (the comparison programme) so that a mapping process can be undertaken.

Mapping, in this case, refers to detailed analysis of a feature of an education programme (generally as represented within that programme's documentation). Specifically, mapping applies the same analytical method to two separate sets of data (for example, the learning outcomes of two different curricula), enabling similarities and differences between those two data sets to be understood through the different results of applying the same mapping method to both. Another important feature of mapping is that there is a paper trail of the analysis, as the approach is methodical, testable, and repeatable.

For more information on how mapping has been applied in this study, see sections 3.2.1 and 3.2.2.

3.2.1 Method: Programme-Level Comparison

Each aspect of the programme-level comparison is achieved through slightly different approaches to mapping and assessing alignment, the results of which inform the overall alignment evaluation. Each method is described in the appropriate subsection below.

Philosophical Underpinnings

In the DP, the ATL, the learner profile, and the framework of international-mindedness were used to represent the philosophical underpinnings, while the 'transversal competences' section of the National Core Curriculum for GUSE was used for the FNCC/GUSE. [8]

In order to carry out the comparative analysis, six themes were extracted from the DP's philosophical underpinnings:

Table 5: Philosophical underpinning themes

Philosophical underpinning themes
• International outlook, diversity, and intercultural understanding • Grounded in real world contexts

[8] Ibid.

- Principled and community-oriented
- Independence/self-management, critical inquiry, and reasoning
- Communicative and collaborative competency
- Conceptual thought and understanding.

This list of themes was mapped against both the DP's philosophical underpinnings and the philosophical underpinnings of the FNCC to identify what aspects of the DP's philosophical underpinnings are shared with the FNCC and what aspects are unique to either the FNCC's philosophical underpinnings or the DP's. The detail of this mapping was carried out in the mapping spreadsheets, while a visual summary and written explication of the findings can be found in the Philosophical Underpinnings section below (see section 4.2).

Structure

Comparing the structures of the DP and a national programme does not require a mapping process. Instead, subject offerings, how duration interacts with subjects/progression, and the general structure of the qualification (including exit points) have been represented with visuals for each programme. These curriculum structure diagrams use block colours and simple box and arrow graphics to demonstrate structure and progression.

Curriculum structure diagrams have been placed next to each other in this report to show the similarities and differences at a glance. The visual presentation is followed by a short write-up of the key similarities and differences, to maintain analytical focus on the alignment of the two programmes.

Requirements and Associated Outcomes

The requirements and associated outcomes of each programme are, like the structure, also simple, core features which do not require a mapping process in order to be compared. Comparisons and contrasts are drawn between the different requirements (e.g. entry requirements, pass/fail requirements) linked to both programmes and the associated outcomes of both.

Student Learning Pathways

By 'student learning pathways', we refer to the learning route that each student can take through a programme – with focus on scope for subject-specific specialisation. As with the comparative analysis of structure, diagrams resembling flow charts have been used to visually demonstrate the core and optional subject choices, providing an example to indicate how students follow different potential learning pathways in both programmes. A short textual write-up has been included after the diagrams to highlight and discuss the key similarities and differences – maintaining analytical focus on the issue of alignment.

Assessment Methods

Although detailed comparative analysis of assessment is not a main component of the analysis of alignment, Ecctis has briefly considered the high-level assessment features within the programmes being compared.

A simple table has been used, followed by a short textual description of the key similarities and differences. Where possible, the types/numbers of assessment used in the programme

are a source of comparison, and the subjects analysed in the subject-level alignment analysis in each report have been used as examples to consider assessment in more detail (i.e. question types and marking approaches, where this information is available).

3.2.2 Method: Subject-Level Comparison

As previously described, a number of subjects has been selected by the IB for a closer look at alignment at the subject level. This includes a closer look at the learning outcomes for each subject, the subject content, and the demand level. Each approach is outlined below.

Learning Outcomes

To analyse the alignment of learning outcomes at the subject level, the process began by extracting six to eight themes from the DP's subject-level learning outcomes for each subject being analysed, encompassing both skills and knowledge areas. This thematic code was then mapped onto the learning outcomes of the DP subject and the comparison subject from the FNCC.

The top-level results of the mapping process are represented with a table per subject area. Following the tables, a written commentary is provided regarding the presence of DP knowledge areas and skills (represented by themes) in the FNCC and any knowledge areas and skills found in the FNCC but not in the DP.

Content

To compare the content of the DP subject and the comparison FNCC subject, both are first presented next to each other in the document in a simple tabular format. Additionally, content mapping took place through a simple process of establishing whether each content sub-topic covered by the DP subject in question has 'clear alignment' with any content in the FNCC comparison subject. The mapping spreadsheets demonstrate the full logic of all judgements.

A commentary is provided on DP subject content not found to have alignment points in the FNCC subject and on FNCC subject content topics not found to have alignment points in the DP subject.

Demand

Comparing the demand of subject curricula is perhaps the most complex mapping and alignment analysis within this report. Ecctis' approach views demand from multiple perspectives to capture its relationship to skills as well as to the detail and scope of content.

To allow for a comprehensive assessment of the level of demand of the DP selected subjects against the respective comparison points, Ecctis has created a Demand Profile for each subject in the study. Each Demand Profile comprises four criteria designed to judge complexity, depth, breadth, workload levels and potential for intellectual stretch. These criteria have been applied uniformly across all subjects in the study, using an expert panel-approach (as outlined below).

Demand Profile – Subject-level Judgement

The Demand Profile is comprised of four scores (each between zero and three) based on specific criteria. Each score within each category has a specific definition which is listed in Appendix A. A panel of subject, teaching, and curriculum design experts analysed each subject curriculum and arrived at a consensus on which score descriptor in each category best matched with the curriculum in question. The categories which comprise the Demand Profile are as follows:

- **Revised Bloom's Cognitive Skills** score (0-3): this is an overall score of course demand, based entirely on a review of learning outcomes. Levels have been defined based on increasing emphasis of higher order cognitive skills taken from Bloom's Revised Taxonomy.[9]

- **Depth of Knowledge** (adapted from Webb's) score (0-3): this is an overall score evaluating the depth of knowledge or complexity of knowledge and skills required by curriculum standards and expectations. The score is focused on subject content and learning outcomes, complemented by assessment where relevant/possible. Levels have been defined based on the level of detail studied per topic, as well as the levels of thinking described in Webb's Depth of Knowledge framework.[10]

- **Volume of Work** score (0-3): this is a trifactor score, considering:
  a. breadth of content – i.e. how many topic and sub-topics are covered
  b. depth of content – i.e. the extent to which the topics and sub-topics are focused upon, amplified and explored.[11]
  c. specified timeframe – i.e. the time allocated for studying the subject.

  The three factors – breadth, depth, and time – were all considered in defining the levels.

- **Outstanding Areas of Subject Demand** score (0-3): this score reflects the number of content areas viewed as more challenging and/or conducive to intellectual stretching of students. Levels have been defined on a scale of increasing number of 'stretch areas'.

Demand Panel: Expert Judgement Procedure

Demand analysis and judgements against the above criteria rested with a panel of experts comprised of both curriculum and teaching experts – i.e. international education researchers experienced in comparative secondary curriculum evaluation – and subject experts – i.e. researchers and consultants with a subject specialism in the relevant subject areas. For both expert types, teaching experience, understanding of appropriate national/international

[9] Krathwohl, D. (2002). A Revision of *Bloom's taxonomy: An Overview.* Theory Into Practice, Vol 41(4). Available from: www.tandfonline.com/doi/abs/10.1207/s15430421tip4104_2?journalCode=htip20

[10] Webb, N. L. (2002). *Depth-of-knowledge levels for four content areas*. Language Arts. Available from: Microsoft Word - Webb DOK all content.doc (pbworks.com)

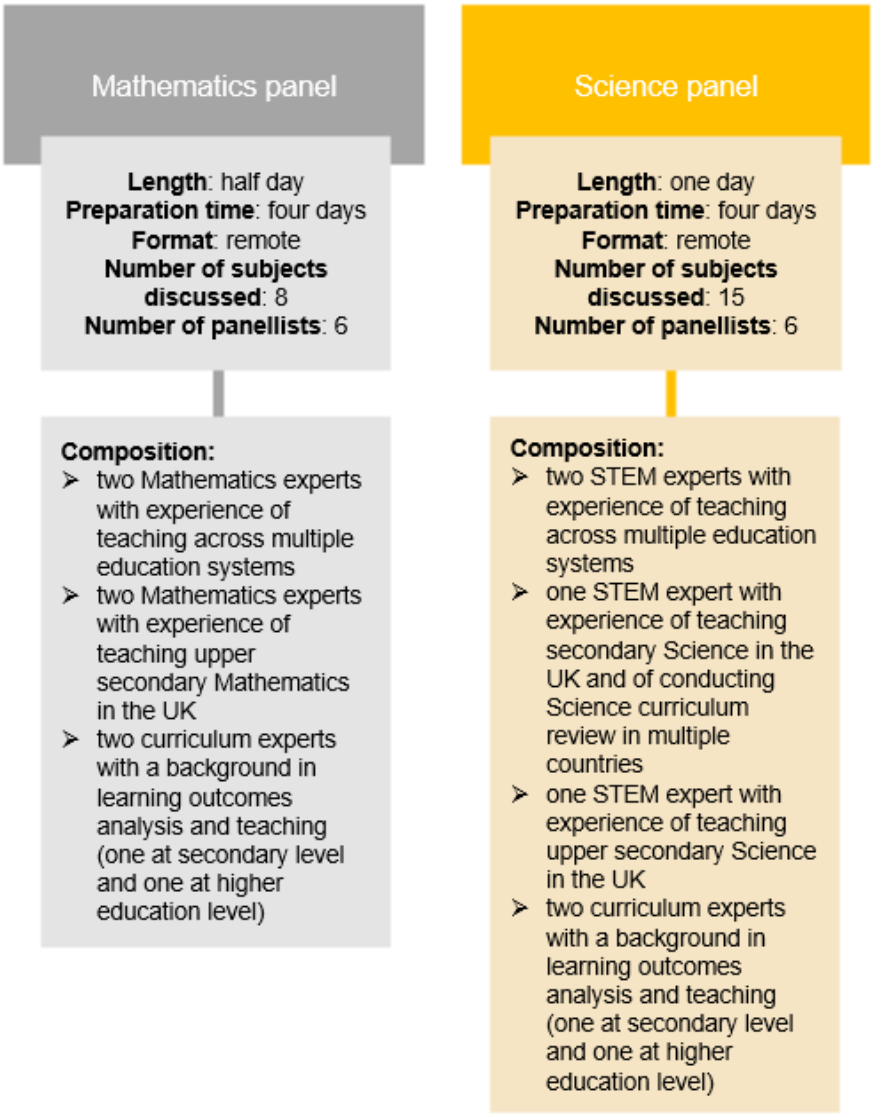
[11] Note: 'depth of content' primarily describes what is on the curriculum (i.e. the level of detail comprised in each topic), whereas 'depth of knowledge' describes what the students need to be able to do (i.e. how complex and extensive the thinking processes involved are).

teaching contexts, and experience of curriculum and learning outcomes comparisons were prioritised.[12]

For the panels discussing the demand level of the DP subjects and respective comparison subjects in the Singapore, Finland and South Korea reports, the composition of each panel was as follows:

[12] To minimise potential biases and subjectivity, Ecctis' recruitment procedure excluded candidates with experience of teaching any of the comparison qualifications in this study.

Figure 1: Demand panels details



All panellists were provided with the relevant extracts from the appropriate qualifications' specifications, including (where available):

- Learning outcomes and aims of the qualification
- Assessment structure
- Information about guided learning hours or curriculum time
- Assessment objectives
- Content.

The experts were also provided with a document containing:

- An introduction to the comparative analysis task
- Descriptions of the demand taxonomies
- The demands instrument (used to record findings).

Panellists conducted between three and four days of panel preparation, reviewing the appropriate curriculum documentation in detail and scoring each subject against the demand criteria provided (the template utilised for this has been included in Appendix C). Following this preparation, participants then took part in their respective panels, which were all hosted remotely on Microsoft Teams. The science demand panel lasted one full working day, while the mathematics panel lasted for half a day due to the lower number of subjects being discussed.

All judgements resulted in scores from 0-3 for each demand criterion mentioned above, with each score for each criterion being pulled into each course's demand profile. The panel approach was used to debate the findings and scores reached by each member of the panel and arrive at an evidence-based consensus on every demand score for every subject.[13]

Visually, each demand profile is represented by radar diagrams to facilitate demand comparison between subjects.

NB: all demand scores produced should be interpreted as approximate judgements given the varying degrees of documentation and detail available for each curriculum, as well as likely variation on how the curricula are implemented in practice.

[13] Note: each score was debated by the panel until a unanimous agreement was reached.

4. Programme-Level Alignment

This section focuses on answering RQ2 and the sub-questions associated with it, namely:

Table 6: Research question 2

RQ2: To what degree do the curricula align with regard to their: 2.1: Philosophical underpinnings • Objectives • Principles • Values? 2.2: Structure • Learning areas • Subject offerings • Degree of specialization • Time allocation? 2.3: Requirements • Programme entry requirements • Time requirements (i.e. programme duration, teaching hours, study hours) • Certificate requirements (i.e. credits, passing and failing conditions, compensation options)? 2.4: Assessment • Nature of assessment (i.e. number, type, duration, question types, availability of marks) • Assessment model (i.e. relative weighting of assessments to overall grades)? 2.5: Student learning pathways • Degree of specialization • Options in subject (area) choice (i.e. compulsory subjects, electives)?

It starts by offering top-level overviews of both the DP and the FNCC/GUSE, followed by presenting the results from the programme-level comparative analysis for each core component outlined above.

4.1 Programme Overviews

4.1.1 The International Baccalaureate Diploma Programme

The Diploma Programme (DP) was established in 1968 as a two-year pre-university programme for 16–19-year-old students.[14]

Students who aim to achieve the Diploma award must generally select one subject from each of the six subject groups:

- Studies in language and literature
- Language acquisition
- Individuals and societies
- Sciences
- Mathematics

[14] International Baccalaureate. (2015). *Diploma Programme. From principles into practice*. p. 5.

- The arts.[15]

Students who do not wish to take a subject from the arts subject group may opt to study an additional sciences, individuals and societies, or languages course instead.

All subjects are studied concurrently over the two-year duration of the programme and most subjects can be taken at either HL or SL. In terms of teaching hours, the DP's documentation recommends 150 teaching hours for individual subjects at SL and 240 teaching hours are at HL.[16]

In addition to the six subjects taken from these groups, DP students will also need to complete three further curriculum components. Theory of knowledge (TOK) allows students to reflect on the nature of knowledge by considering their subjects from a broader perspective.[17] The extended essay is a self-directed piece of research which results in a 4000-word essay.[18] Creativity, activity, service (CAS) is not formally assessed but requires that students undertake a creative endeavour, take part in something physically active, and participate in a voluntary or unpaid activity.[19] Together, these three components comprise the DP 'core'.

To achieve the IB Diploma a student must take at least three HL subjects.[20] The maximum number of subjects that can be taken at higher level is four. HL subjects are intended to prepare learners for the discipline specialisation of higher education, whilst the SL subjects balance this by broadening the range of subjects studied.[21]

The DP curriculum framework is based on a concentric circle model (see below), whereby the learner profile is positioned at the centre to represent its relevance to all aspects of the programme. The next circle comprises the core requirements of TOK, the extended essay, and CAS. The six subject groups are then encircled by international-mindedness and the programme title – indicating that everything students study is unified by the underpinning philosophy of encouraging thinking from a perspective that embraces other points of view outside one's own frame of reference.

[15] International Baccalaureate. (2021). *Curriculum*. Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/
[16] Ibid.
[17] International Baccalaureate. (2021). *Theory of knowledge*. Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/theory-of-knowledge/
[18] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 2.
[19] International Baccalaureate. (2021). *CAS projects. Available from:* https://www.ibo.org/programmes/diploma-programme/curriculum/creativity-activity-and-service/cas-projects/
[20] International Baccalaureate. (2021). *Curriculum*.
[21] International Baccalaureate. (2015). *Diploma Programme: From principles into practice*. p. 6.

Figure 2: IB Diploma Programme curriculum model[22]

Both internal and external assessment methods are used in the DP. In most subjects, students take written examinations at the end of the programme that are marked by external IB examiners. Internally assessed tasks normally comprise between 20-30% of the total mark in each subject.[23]

Question types used in DP assessment vary from subject to subject. Essays, structured problems, short-response questions, data-response questions, case-study questions, and multiple-choice questions are some of the external assessment question types deployed.[24] Coursework forms part of the assessment for areas of the DP such as the extended essay and TOK.[25] This is normally carried out over an extended period under teacher supervision. Where students complete internally assessed tasks, these are marked by teachers and moderated by the IB.[26] Some of the internal assessment methods used include oral work in languages, fieldwork in geography, laboratory work in the sciences, and artistic performances in the arts.[27]

Each DP subject, whether taken at SL or HL, is graded from 1-7 (with 7 representing the highest achievement level).[28] If a student has taken enough subjects at the correct level to be

[22] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 2.
[23] International Baccalaureate. (2021). *Understanding DP assessment*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/; International Baccalaureate. (2014). *Diploma Programme: A guide to assessment*. p. 3.
[24] International Baccalaureate. (2021). *Assessment and Exams*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/
[25] International Baccalaureate. (2021). *Understanding DP assessment*.
[26] Ibid.
[27] International Baccalaureate. (2021). *Assessment and Exams*.
[28] International Baccalaureate. (2021). *Understanding DP assessment*.

in contention for the Diploma award, a minimum of 24 points is needed to achieve the qualification. A minimum grade of 3 is also needed in at least four subjects to achieve the qualification.[29]

Additionally, 42 total points are available from the combination of the grades for six subjects and a further three points are available to students for successful completion of the core elements of TOK, the extended essay, and CAS. The TOK and extended essay components of the DP are each marked on an A-E scale, where an A grade is the highest award, and an E grade the lowest.[30] Their combined results can contribute up to three additional numerical points to the overall DP score (see Table below). CAS does not constitute a graded part of the DP, although its completion is mandatory to be awarded the Diploma.

HL and SL subjects are assessed against the same grade descriptors;[31] however, HL candidates are expected to demonstrate the various elements of the grade descriptors across a greater range of knowledge, skills, and understanding.

A bilingual Diploma is awarded to students who achieve:

- Grade 3 or higher in two language subjects from subject group 1, or,
- Grade 3 or higher in a group 1 language subject and a grade 3 or higher in a group 3 or 4 subject taken in a different language.

Certificates are awarded to students that have taken individual subjects but not enrolled on the full Diploma, or DP candidates who do not complete the full DP.[32] Prospective candidates can enrol in as many individual subjects as permitted by their school; these are graded with the same 1-7 system used in the full DP.

Table 7: Letter-Grade: numerical score conversion matrix[33]

		Theory of knowledge (TOK)				
	Grade awarded	A	B	C	D	E
The extended essay	A	3	3	2	2	Failing condition
	B	3	2	2	1	
	C	2	2	1	0	
	D	2	1	0	0	
	E	Failing condition				

No formal entrance requirements are stipulated as the IB envisages numerous educational pathways leading to the DP.[34] However, the IB recommends consulting the subject guides prior to enrolment to ensure an adequate understanding of programme expectations.[35]

[29] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 4.
[30] Ibid.
[31] International Baccalaureate. (2021). *Understanding DP assessment*.
[32] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 4.
[33] International Baccalaureate. (2017). *Assessment principles and practices: Quality assessments in a digital age*. p. 220.
[34] International Baccalaureate. (2015). *Diploma Programme: From principles into practice*. p. 22.
[35] Ibid.

4.1.2 Finland National Core Curriculum for General Upper Secondary Education

The school system in Finland is overseen by the Finnish National Agency for Education (EDUFI).[36] Compulsory education is divided into Basic Education (years 1-9) and General Upper Secondary Education (GUSE). In Finland, students must study until they graduate from secondary education or reach the age of eighteen.[37] GUSE is typically three years in duration, yet students may complete the certificate in two or four years; as a result, the qualification is very fluid and there are no grade-specific classes. GUSE is also available for adult learners, delivered in separate institutions, on a part-time basis.[38]

An extensive reform to GUSE was launched in 2017, with changes to the Act on GUSE and the Government Decree on GUSE.[39] The aforementioned documents form the basis of the FNCC, produced by EDUFI, with input from teaching staff, students, students' guardians, and relevant authorities. The FNCC underpins all local curriculum offerings.

Structure

Secondary education in Finland comprises both a general stream and a vocational stream. In order to access GUSE, students are required to have passed the Basic Education Certificate or have equivalent qualifications or knowledge; an education provider may issue additional selection criteria.[40] According to EDUFI, 'education providers may decide how to draw up their local curricula on the basis of the national core curriculum'.[41] This means that 'the order in which the studies in a subject are completed and the way in which they are divided into study units are decided in the local curriculum'.[42]

Moreover, the scope of the syllabus varies widely among students as they produce a personal plan to guide their choices, to which detail can be added throughout the course of their studies. Alongside a study plan, the personal plan also features a matriculation examination plan, a plan for further studies, and a career plan.[43] Thus, the structure of the programme is highly fluid, though there are specific credit requirements in order to complete it (see below).

Credit Requirements

In the FNCC/GUSE, each subject area is composed of different *subjects*, some of which contain different choices of *syllabi* – e.g. biology is a subject with no optional syllabi, while mother tongue and literature is also a subject but contains multiple syllabi (12), which students must choose from depending on their mother tongue. Subjects/syllabi, in turn, contain *studies* (also referred to as 'modules') – both *compulsory studies* and *national optional studies* – each study carrying different credit values.

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[36] Finnish National Agency for Education. (2022). Available at: https://www.oph.fi/en
[37] Ministry of Education and Culture, Finland. (2020). *Act on Compulsory Education (1214/2020).* Available from: https://www.finlex.fi/fi/laki/ajantasa/2020/20201214
[38] Ministry of Education and Culture, Finland. (2018). *Act on General Upper Secondary Education (714/2018).* Available from: https://www.finlex.fi/en/laki/kaannokset/2018/en20180714
[39] Finnish National Agency for Education. (2019). *National Core Curriculum for General Upper Secondary Education*. p. 10.
[40] Ministry of Education and Culture, Finland. (n.d.). *General Upper Secondary Education.* Available from: https://okm.fi/en/general-upper-secondary-education
[41] Finnish National Agency for Education (2019) *National Core Curriculum for General Upper Secondary Education*. p. 14.
[42] Ibid, p. 20.
[43] Ibid, p. 33.

In order to complete general upper secondary education, students must have 'passed the subject syllabi and completed the minimum scope of general upper secondary education studies, or 150 credits'.[44] Of these 150 credits, a minimum of 20 must have been obtained from the completion of national optional studies. For reference, each credit is equivalent to fourteen hours and fifteen minutes of teaching, in addition to independent study.[45]

Students must study the *compulsory credits* from all of the subjects listed in the table below: i.e. mother tongue and literature, second national language (either Finnish or Swedish), foreign languages, mathematics, biology, geography, physics, chemistry, philosophy, psychology, history, social studies, religion or worldview studies, health education, physical education, music, visual arts and guidance counselling. More specifically, when it comes to:

- Languages: students must choose one 'foreign language, A syllabus' and one 'foreign language, B1 syllabus', with the option of studying additional foreign languages.
- Mathematics: all students must take the common study module, but can then choose between studying the 'Advanced syllabus in mathematics' or the 'Basic syllabus in mathematics'.
- Religion/Worldview studies: depending on their religious views, students must study either Religion or Worldview studies.

In addition to completing the compulsory studies, students must study a minimum of 20 credits in national optional studies in subjects of their choice to reach their minimum of 150 credits. The remaining credits can either be reached by completing additional national studies or completing thematic studies and general upper secondary school diplomas.

The FNCC does not provide an outline for the specific curriculum to be covered by thematic studies, which are offered at the discretion of the education provider. Local curriculum offers may also include diplomas, worth two credits each, and other optional studies.[46] Students may opt for diplomas in home economics, visual arts, home crafts, physical education, media, music, dance and theatre.[47]

The table below summarises provides a simplified overview of the subject groups, subjects and syllabi outlined in the FNCC:

[44] Ibid, p. 62.
[45] Ministry of Education and Culture, Finland. (2018). *Government Decree on General Upper Secondary Education (810/2018).* Available from: https://www.finlex.fi/fi/laki/alkup/2018/20180810
[46] Diploma is defined in the Act on General Upper Secondary Education (714/2018) as 'studies… that provide evidence of special competence and hobbies in different subject groups or subjects' and does not result in an additional qualification.
[47] Finnish National Agency for Education, (n.d.). *Subjects at General Upper Secondary.* Available from: https://www.oph.fi/en/education-and-qualifications/subjects-general-upper-secondary

Table 8: List of subjects in FNCC[48]

Subject group	Subject	Syllabi available within subject
Mother tongue and literature 12 compulsory credits + 6 optional credits	Mother tongue and literature	*NB: students pick 1 subject from the list below* • Syllabus in Finnish language and literature • Syllabus in Swedish language and literature • Syllabus in Sámi language and literature • Syllabus in Roma language and literature • Syllabus in sign language and literature • Syllabus in Finnish as a second language and literature • Syllabus in Swedish as a second language and literature • Syllabus in Finnish for Sámi speakers • Syllabus in Swedish for Sámi speakers • Syllabus in Finnish for sign language users • Syllabus in Swedish for sign language users • Syllabus in a student's other mother tongue and literature
Second national language 12 compulsory credits for A-syllabi OR 10 compulsory credits for B1 syllabi + 4 optional credits (for either)	Swedish	*NB: students pick either one subject from the Swedish list OR one subject from the Finnish list (depending on their mother tongue)* • Swedish, A syllabus* • Swedish, B1 syllabus* • Swedish, B3 syllabus* • Swedish, native-level syllabus
	(or) Finnish	• Finnish, A syllabus* • Finnish, native-level syllabus • Finnish, B1 syllabus* • Finnish, B3 syllabus*
Foreign languages 12 compulsory credits + 16 optional credits for B2 syllabus + 16 optional credits for B3 syllabus	Foreign languages	*NB: students pick at least one foreign language, and the level they study the language at* • Foreign languages, English, A syllabus* • Foreign languages, A syllabus* • Foreign languages, B1 syllabus* • Foreign languages, B2 syllabus* • Foreign languages, B3 syllabus* • Foreign languages, Asian and African languages, A syllabus* • Foreign languages, Asian and African languages, B3 syllabus* • Foreign languages, Sámi language, A syllabus* • Foreign languages, Sámi language, B2 syllabus* • Foreign languages, Sámi language, B3 syllabus* • Foreign languages, Latin, B2 syllabus* • Foreign languages, Latin, B3 syllabus*
Mathematics	Mathematics	*NB: all students study the common study module, but can choose whether to take the advanced syllabus or the basic syllabus modules*

[48] Finnish National Agency for Education. (2019). *National Core Curriculum (NCC) for General Upper Secondary Education*.

2 compulsory credits (for common study module) + 10 compulsory credits (for basic syllabus) + 4 optional credits (for the basic syllabus) OR 2 compulsory credits (for common study module) + 18 compulsory credits (for advanced syllabus) + 6 optional credits for the advanced syllabus		• Common study module in mathematics (2 compulsory credits) and • Advanced syllabus in mathematics (18 compulsory credits) OR • Basic syllabus in mathematics (10 compulsory credits)
Humanities and natural sciences 48 compulsory credits) + optional credits	Biology (4 compulsory credits + 6 optional credits)	
	Geography (2 compulsory credits + 6 optional credits)	
	Physics (2 compulsory credits + 12 optional credits)	
	Chemistry (2 compulsory credits) + 8 optional credits)	
	Philosophy (4 compulsory credits + 4 optional credits)	
	Psychology (2 compulsory credits + 8 optional credits)	
	History (6 compulsory credits + 6 optional credits)	
	Social Studies (6 compulsory credits + 2 optional credits)	
	(either) Religion (or) Worldview studies (4 compulsory credits + 8 optional credits)	• Evangelic-Lutheran religion • Orthodox religion • Catholic religion • Islam religion • Jewish religion • Other religions
	Health education (2 or 4 compulsory credits + 4 optional credits)	
	Physical education (4 compulsory credits)	
	Music (4 compulsory credits + 4 optional credits) Visual arts (2 or 4 compulsory credits + 4 optional credits)	
	Guidance counseling (4 compulsory credits)	
Optional	Thematic studies (6 optional credits)	
	General upper secondary school diplomas (worth 2 credits each)	
* **For languages:** A-syllabi stands for 'advanced level' B1-syllabi stands for 'intermediate level' syllabi B2 and B3 syllabi stands for 'basic level'.		

Assessment

The Finnish system takes a highly flexible approach to assessment, thus there are no standardised examinations leading to the awarding of the General Upper Secondary Leaving Certificate for GUSE students. Versatile assessment methods and criteria are chosen by each education provider, with assessment and grading conducted internally at the end of each study unit.[49]

Grading is 'calculated as an arithmetic average weighted by the credits obtained by the student in compulsory and national optional studies'.[50] Numerical grades are awarded for compulsory studies and national optional studies, including optional foreign languages, on a scale from 4 to 10. Grade 4 denotes a 'failed' study unit, grade 5 represents 'adequate', grade 6 is 'moderate', grade 7 'satisfactory', grade 8 'good', grade 9 'very good' and grade 10 'excellent knowledge'.[51] EDUFI states that higher grades can be awarded than those achieved in study units, where a student proves greater command of the subject in a separate examination.

Guidance counselling studies, and any studies completed independently, are marked with a Pass (S) or a Fail (H) grade. Optional studies may be awarded a numerical grade or a pass/fail grade, depending on decisions made by the education provider. Oral language skills, for a second national or foreign language, are assessed throughout the course of study but also through an additional assessment produced by EDUFI.[52]

In order to successfully pass a subject, a student must pass most of the studies within it. The table below demonstrates the maximum number of fail grades permitted.

Table 9: Requirements for acceptable completion of subject syllabus[53]

Scope of compulsory and optional studies taken by the student	of which the number of failed grades may not exceed
2 to 5 credits	0 credits
6 to 11 credits	2 credits
12 to 17 credits	4 credits
18 credits or more	6 credits

General Upper Secondary School Leaving Certificates are awarded to students upon completion of the FNCC, with a separate certificate for the oral language proficiency test and for the GUSE diploma, if applicable. Those students who complete one or more subjects are awarded a Certificate for Completion of a Syllabus, whilst those who withdraw before completing the FNCC/GUSE syllabus are awarded a Certificate of Resignation.[54]

Matriculation Exam

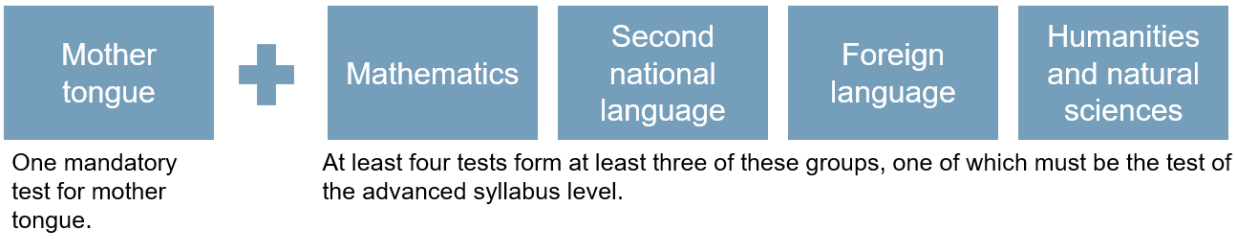
The Finnish Matriculation Examination is the national school-leaving examination and the only standardised assessment in Finland. According to the Act on the Matriculation Examination,

[49] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*. p. 54.
[50] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*. p. 61.
[51] Ministry of Education and Culture, Finland (2018). *Government Decree on General Upper Secondary Education (810/2018).*
[52] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.
[53] Ibid, p. 61.
[54] Ibid, p. 65.

'students who complete the examination have acquired the knowledge and skills specified under the curriculum for general upper secondary education and attained a level of maturity consistent with the objectives of general upper secondary education'.[55] Both general and vocational stream students (see Alternative Awards section below) can sit this examination, in Finnish or Swedish, in order to be eligible for entry into university in Finland, or abroad. The exams have been fully digitalised since 2019 and are administered in schools.[56]

The exams are held in Spring and Autumn each year; students are permitted to sit all examinations in one examination period or over the course of three consecutive rounds, with resits permitted.[57] As of Spring 2022, candidates must take a minimum of five tests: one mandatory test in their mother tongue syllabus, and at least four tests from at least three of the following groups: mathematics, second national language, foreign language, and humanities and natural sciences. It is also a requirement that at least one of these four tests must be the test of the advanced syllabus level. These requirements are summarised in the figure below:

Figure 3: Structure of the Matriculation Examination[58]



Source: Adapted from The Matriculation Examination Board, 2022, available from [https://www.ylioppilastutkinto.fi/en/matriculation-examination/the-examination/structure-of-the-examination].

The mother tongue test can be taken in Finnish, Swedish and Sami. The Finnish and Swedish examinations are composed of two parts which last a maximum of six hours each: a textual skills test and an essay test. The textual skills test assesses students' analytical skills and linguistic expression, as they choose two from a choice of four assignments featuring literary texts, expository texts, and artwork before producing analysis, summary, or commentary. The essay test assesses a general level of education, development of thinking, linguistic expression, and coherence, as students choose one essay assignment from a choice of five. In contrast, the Sami language test features only an essay test. The mother tongue test can be replaced by a test of Finnish or Swedish as a second language, by those students whose mother tongue is not Finnish, Swedish or Sami. A candidate may also take the mother tongue test in Finnish or Swedish, in lieu of the second national language test in that language.[59]

[55] Ministry of Education and Culture, Finland. (2019). *Act on the Matriculation Examination (502/2019)*. Available from: https://finlex.fi/en/laki/kaannokset/2019/en20190502
[56] Matriculation Examination Board. (2021). *Matriculation Examination.* Available from: https://www.ylioppilastutkinto.fi/en/matriculation-examination
[57] Matriculation Examination Board. (2021). *Regulations and guidelines*. Available from: https://www.ylioppilastutkinto.fi/en/regulations-and-guidelines
[58] Matriculation Examination Board. (2021). *Structure of the examination*. Available from: https://www.ylioppilastutkinto.fi/en/matriculation-examination/the-examination/structure-of-the-examination
[59] Matriculation Examination Board. (2021). *Description of tests.* Available from: https://www.ylioppilastutkinto.fi/en/matriculation-examination/the-examination/description-of-tests

Tests in the second national language (Finnish or Swedish) are offered at advanced or intermediate syllabus level. Foreign language tests in English, French, German, Russian and Spanish are arranged at advanced and basic syllabus level, whereas tests in Italian, Inari Sami, North Sami, Skolt Sami, Latin and Portuguese are only offered at basic syllabus level and Latin is offered at extended basic syllabus level. For most language tests there are two parts: a listening comprehension test and the test of written comprehension and production. The latter is composed of three parts, with the possibility of multiple-choice questions, cloze tests, open questions, summaries, and translation or description assignments. At advanced level, there is a written assignment of 700 - 1,100 characters, or 700 - 1,300 in the English and Finnish tests. At basic and intermediate level, there is one shorter assignment (160 - 240 characters) and one longer assignment (300 - 450 characters). The tests in Inari Sami, North Sami, Skolt Sami, Latin and Portuguese do not include a listening comprehension test.[60]

The mathematics tests are available at basic or advanced syllabus levels. Candidates must complete ten questions out of a possible thirteen and each question carries a maximum of twelve points. The tests have two parts: Part A and Part B. Part B is further divided into two parts: Part B1 and Part B2. Part A consists of four questions, all of which are compulsory. A calculator may be used in Part B but not in Part A. Part B1 consists of five questions, of which the candidate chooses three, and Part B2 consists of four questions, of which the candidate also chooses three.[61]

Each subject in the category of humanities and natural sciences has its own test, with a maximum duration of six hours. The exams in this subject group are held over two days, with a specific number of subjects available on each day. In physics, chemistry and biology, the candidate answers a maximum of seven questions out of eleven. In the remaining subjects, the candidate answers a maximum of five questions out of nine. In the digital tests for humanities and natural sciences, the maximum score is 120 points, and some questions may be compulsory. Test items may be traditional essay questions, multiple-choice questions, drawing assignments, data analyses, or combinations of these, the tests may also feature more diverse background material than in traditional paper tests. Questions may include text, pictures, videos, tape recordings, maps, animations, and statistics. The maximum score for a test item varies between 15 and 30 points.[62]

Additional optional examinations may also be taken at any time and are of equal value to the compulsory examinations. Although the examination undergoes preliminary marking by a student's teachers, subsequent external marking is undertaken by the Matriculation Examination Board (MEB). As a centralised body, the MEB standardises the awarding of grades by using a specially designed formula to ensure comparability between subjects and cohorts.[63]

Grading of the tests in the matriculation examination is shown in the table below.

[60] Ibid.
[61] Ibid.
[62] Ibid.
[63] Matriculation Examination Board. (2021). *Assessment of the examination.* Available from: https://www.ylioppilastutkinto.fi/en/assessment-and-certificates/assessment-of-the-examination

Table 10: Grading of the matriculation examination, with typical grade distribution [64]

Grades (Latin Descriptor)	Translation	Points	Distribution of Grades
Laudatur (L)	Excellent	7	5%
Eximia cum laude approbatur (E)	Exceptionally good	6	15%
Magna cum laude approbatur (M)	Very good	5	20%
Cum laude approbatur (C)	Good	4	24%
Lubenter approbatur (B)	Satisfactory	3	20%
Approbatur (A)	Pass	2	11%
Improbatur (I)	Fail	0	5%

The points awarded do not serve an official purpose and are not included on the Certificate of the Matriculation Examination. Instead, these points are used for calculating mean grades per subject, as well as an overall 'pass' or 'fail' grade.

Alternative awards

Although this report focuses on the Finnish General Upper Secondary curriculum, a vocational route is also available to students who do not wish to pursue the general stream.

Vocational education and training (VET)

Approximately half of students completing Basic Education in Finland pursue vocational education and training (VET), with the other half pursuing GUSE.[65] VET also underwent a reform in 2018, with EDUFI preparing the national requirements for approximately 160 vocational qualifications.[66] There is a particular emphasis on practical competences, with flexibility over curricula, as students follow a tailored personal competence development plan.[67]

There are no mandatory final examinations in VET. Instead, students are awarded a certificate by a VET provider, for an entire qualification, or for the units completed.[68] The VET is of equal value to GUSE and allows those successful in the qualification to access further and higher education.[69] Students can also choose to sit the Matriculation Examination like their peers in the general stream.[70]

Curriculum Design Principles

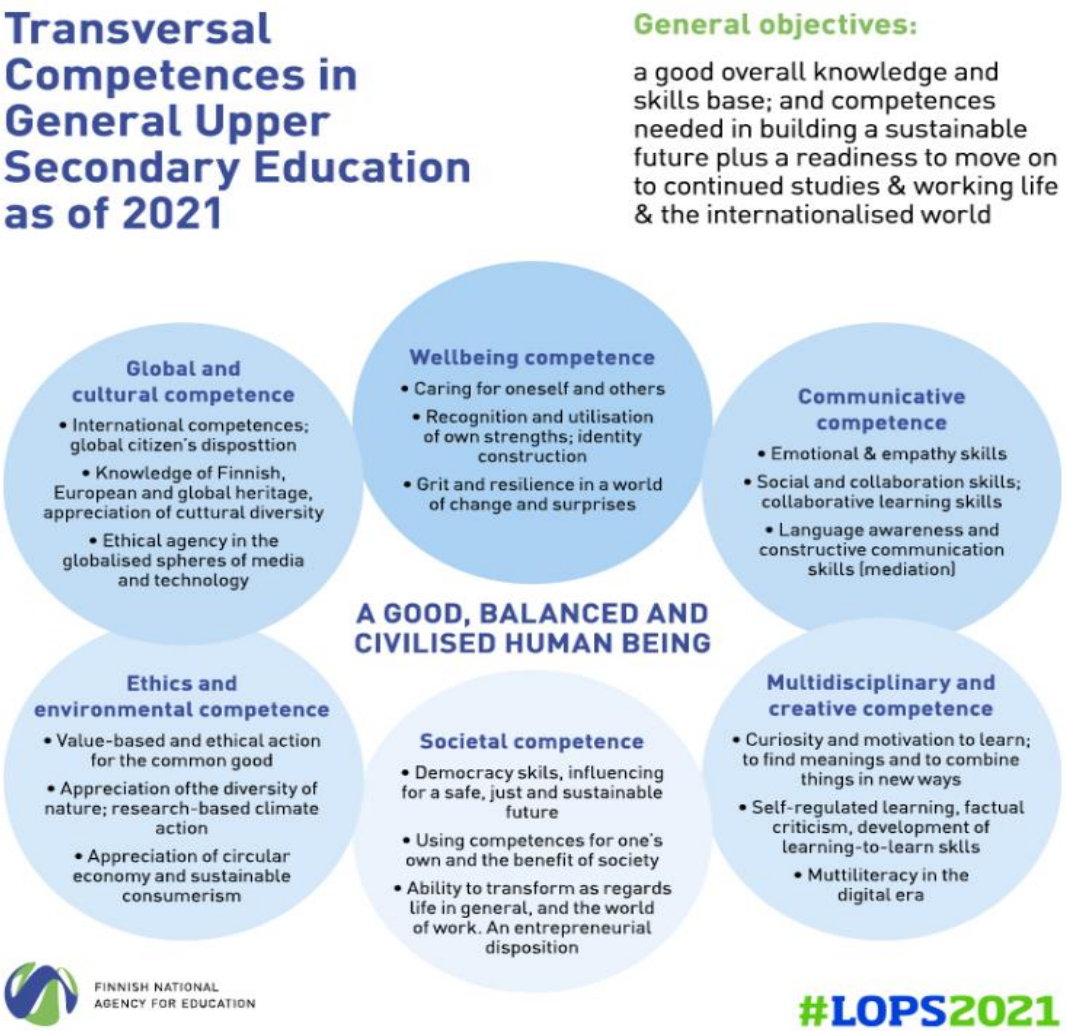
The purpose of GUSE in Finland is to give students 'the competences to pursue tertiary education studies in a university or a university of applied sciences'.[71] The principal mission of GUSE is articulated in the 'Mission and underlying values of general upper secondary

[64] Ibid.
[65] Finnish National Agency for Education and Ministry of Education and Culture, Finland (2019). *Finnish VET in a Nutshell.* Available from: https://www.oph.fi/en/statistics-and-publications/publications/finnish-vet-nutshell
[66] Ministry of Education and Culture, Finland. (n.d.). *Reform of vocational upper secondary education.* Available from: https://okm.fi/en/reform-of-vocational-upper-secondary-education
[67] Finnish National Agency for Education and Ministry of Education and Culture, Finland. (2019). *Finnish VET in a Nutshell.*
[68] Ibid.
[69] Ministry of Education and Culture, Finland. (n.d.). *Qualifications and studies in vocational education and training.* Available from: https://okm.fi/en/qualifications-and-studies_vet
[70] Ministry of Education and Culture, Finland. (2022). *Finnish matriculation examination.* https://okm.fi/en/finnish-matriculation-examination
[71] Ministry of Education and Culture, Finland. (2018). *Act on General Upper Secondary Education (714/2018).*

education' of the EDUFI's 'National Core Curriculum for General Upper Secondary Education'.[72] In this, it becomes apparent that GUSE prioritises the development of students who are able to transition into further study and work, through an education system based on democracy, equality, open-mindedness and sustainability, whilst underpinned by key human rights conventions. Notably, the FNCC does not dictate teaching methods, yet education providers are encouraged to consider expertise available in other institutions, including higher education institutions, to allow students a broader experience.

Transversal competences, shown in the figure below, function as the key curriculum design principles for GUSE and are outlined in the 'Learning objectives and core contents of education' of the EDUFI's 'National Core Curriculum for General Upper Secondary Education'.[73] The FNCC specifies how these can be embedded in the syllabus and objectives of each subject at GUSE, although the implementation is the responsibility of each education provider. A student must also meet the transversal competence objectives in formative and summative assessment, as well as the assessment criteria, to pass a study unit.[74]

Table 11: Transversal competences in FNCC[75]

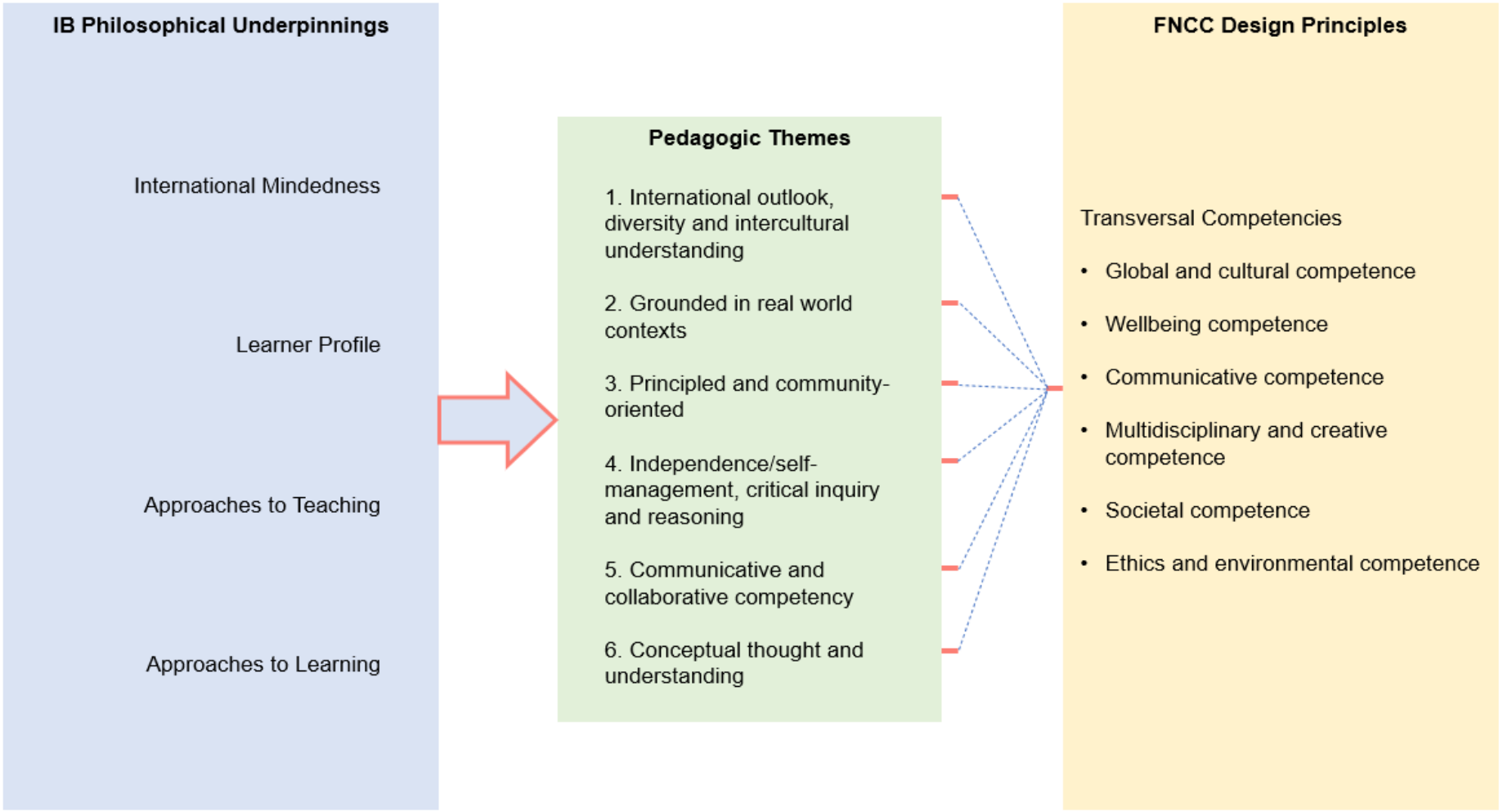


[72] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.
[73] Ibid.
[74] Ibid.
[75] Ibid. p. 70

Notably, the FNCC places significant emphasis on developing students to become confident in drawing up their own plans for the future, grow into global citizens and practice continuous learning. The Finnish ideal of education states that ‘studying and learning are deemed to regenerate society and culture’ and, therefore, education should comprise ethical reflection, caring for others, open-mindedness, and the commitment to act for positive change.[1] Each local curriculum then adds detail to these underlying values by determining how the objectives and core contents of the national core curriculum are to be delivered.

4.2 Philosophical Underpinnings

Figure 4: Philosophical underpinnings comparative analysis diagram for the DP and FNCC



The IB learner profile, which is used across all IB programmes including the DP, outlines 10 attributes that all students should strive towards.[76] Linked to these attributes, there are five categories of approaches to learning skills that all IB programmes aim to develop as well as six categories of approaches to teaching principles. The table in Appendix B presents these qualities of the IB's underpinning philosophies along with the overview used in IB documentation to describe the quality of international-mindedness that also encircles all IB teaching and learning.

The six themes identified within the IB literature have relatively consistent presence across all component parts (learner profile, ATL and international-mindedness). As a result, these themes present a 'boiled-down' version of the DP's philosophical underpinnings.

To identify the level of alignment in relation to the philosophical underpinnings between the DP and the FNCC/GUSE, the project team mapped the philosophical underpinnings of the FNCC/GUSE against six themes extracted from the DP's philosophical underpinnings.

Table 12: Philosophical underpinning themes

Philosophical underpinning themes
• International outlook, diversity, and intercultural understanding • Grounded in real world contexts • Principled and community-oriented • Independence/self-management, critical inquiry, and reasoning • Communicative and collaborative competency • Conceptual thought and understanding

When mapping the six DP themes onto the FNCC transversal competences, it is apparent that all six DP themes are present in the Finnish context. In fact, many of the DP themes are comprehensively covered across the six component competences of the FNCC design principles, indicating that the Finnish curriculum operates on similar philosophical underpinnings to the IB curriculum. In particular, the themes that are most strongly present in the Finnish context, with elements featuring across multiple sub-sections of the six transversal competences, include: 'grounded in real world contexts', 'principled and community-oriented', 'independence/self-management, critical inquiry and reasoning' and 'conceptual thought and understanding'.[77]

As in the DP, FNCC/GUSE students are consistently encouraged to engage in real world contexts by considering world views and identities, the UN 2030 Agenda, and ecological, economic, social and cultural dimensions of their environment, whilst also conducting civic engagement, promoting democracy and learning about further studies and the world of work.[78] They become community-oriented by considering the diversity of their environment, appreciating the cultural identity of their peers, adopting responsibilities to promote the well-being and democracy of other communities, considering the power of technology in extending learning beyond the educational institution, and successfully integrating into their own school

[76] International Baccalaureate. (2017). *What is an IB education?*
[77] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.
[78] Ibid.

community with active citizenship.[79] Also like the DP, FNCC/GUSE students build their identity, resilience, independence levels and critical thinking skills through investigation, evaluation and problem-solving activities regarding self-care and self-regulation, social functionality and calculated risk-taking.[80] Moreover, students are encouraged to develop conceptual thought, advancing their knowledge, understanding and metacognition through analysis and regular reflection, recognising their strengths and development areas, to prepare for higher education.[81]

Only two sections – the 'communication and collaborative competency' and 'international outlook, diversity and intercultural understanding' sections of the IB principles – are not referenced consistently across *all* sub-sections of the six transversal competences in FNCC. For example, there is little mention of 'communication and collaborative competency' in the transversal competences of 'multidisciplinary and creative competence', 'societal competence' or 'ethical and environmental competence'. Furthermore, there is also negligible mention of the 'international outlook, diversity and intercultural understanding' theme in the transversal competence of 'multidisciplinary and creative competence'. That said, the themes are comprehensively covered across the remaining four sub-sections of the FNCC transversal competences section, indicating that the Finnish curriculum operates on similar philosophical underpinnings to the IB curriculum.

One difference is in the emphasis given to technology within the two programmes. Several of the transversal competences in the Finnish curriculum make specific reference to technology – for example, within the 'global and cultural competence', students are expected to gain skills related to 'ethical agency in the globalised spheres of media and technology', whilst within the 'multidisciplinary and creative competence' there is reference to 'multiliteracy in the digital era'.[82] Although there is a very brief acknowledgement of the impact of 'emerging technologies' in the IB documentation, it is not detailed as part of the learner attributes at programme level.[83]

Another potential difference identified between both programmes was the level of detail provided. While both programmes share very similar pedagogical principles, the FNCC includes sub-sections within each transversal competence which provide more detail on the specifics of the curriculum to be studied, than the DP learner attributes.[84] Consequently, there appears to be more flexibility in DP delivery, while schools offering FNCC may find that they need to cover a more specific set of themes to ensure philosophical alignment with the suggested curriculum. However, each DP subject guide also provides additional detailed guidance on how to make links to the IB's philosophy, bringing the two programmes even closer together in practice.

Finally, the 'global and cultural competence' of FNCC references 'knowledge of Finnish, European and global heritage', while the IB focuses solely on the international aspect.[85]

[79] Ibid.
[80] Ibid.
[81] Ibid.
[82] Ibid, p. 71.
[83] International Baccalaureate Organization. (2017). *What is an IB education?*
[84] Ibid, p. 71.
[85] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.

Overall, the philosophical underpinnings of the DP and FNCC/GUSE are very strongly aligned, with the main differences being the degree of emphasis on technology and national identity.

4.3 Structure

There are six subject groups comprising the DP and students pursuing the Diploma award are normally required to select one subject from each of the six groups.[86] The DP also has three core components which are compulsory and are carried out alongside the grouped subjects. The FNCC/GUSE includes eighteen subject areas; students select modules from each subject area to design their own study units. Modules are described as either compulsory or national optional studies and carry different credit values. Students must choose compulsory studies within each subject area, as well as a minimum of 20 credits in national optional studies, to make a minimum total of 150 credits.[87] Compulsory studies in each subject area of the FNCC/GUSE carry the following credit values: mother tongue (12 credits), second national language (10 credits), foreign language A (12 credits), mathematics *general* (two credits), mathematics *short* (10 credits) or mathematics *long* (18 credits), biology (four credits), geography (two credits), physics (two credits), chemistry (two credits), philosophy (four credits), psychology (two credits), history (six credits), social studies (six credits), religion/world view studies (four credits), health education (two credits), physical education (four credits), music (two to four credits) and art (two to four credits) and guidance counselling (four credits).[88] In addition to the 18 compulsory subjects, students will take national optional studies to extend their knowledge in some of these 18 subjects, and can also opt for thematic studies and other optional studies, offered at the discretion of the education provider. Students can also earn two credits per general upper secondary diploma, which may be offered as part of the local curriculum.[89]

The figures below present the subject groups of the DP in comparison with the structure of the subjects that cover similar areas of learning in FNCC/GUSE.

[86] International Baccalaureate. (2021). *How the Diploma Programme Works*. Available from: https://www.ibo.org/programmes/diploma-programme/what-is-the-dp/how-the-diploma-programme-works/
[87] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*. p. 62.
[88] Finnish National Agency for Education. (2022). *Subjects at General Upper Secondary*. Available from: https://www.oph.fi/en/education-and-qualifications/subjects-general-upper-secondary
[89] Finnish National Agency for Education. (n.d.). *Subjects at General Upper Secondary.*

Figure 5: Structural overview of the DP

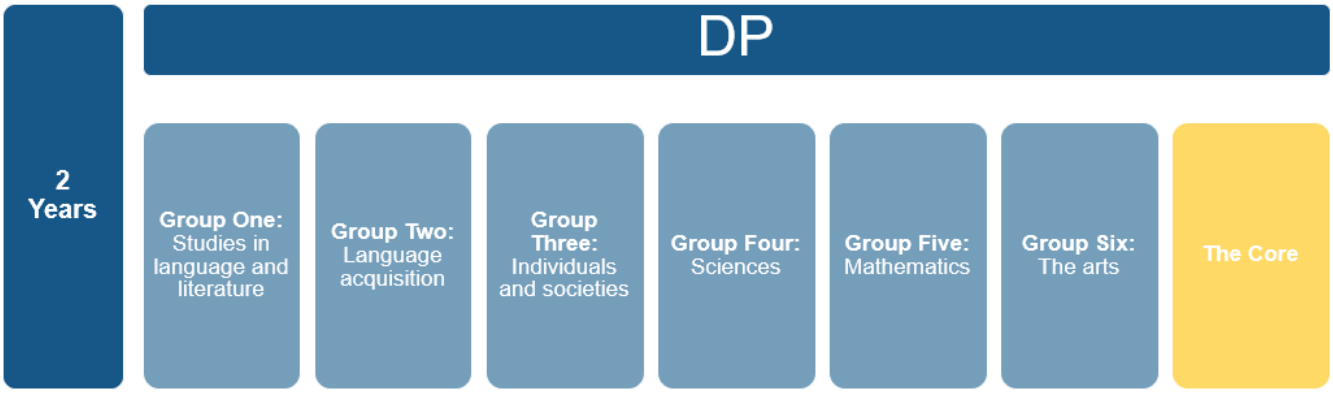
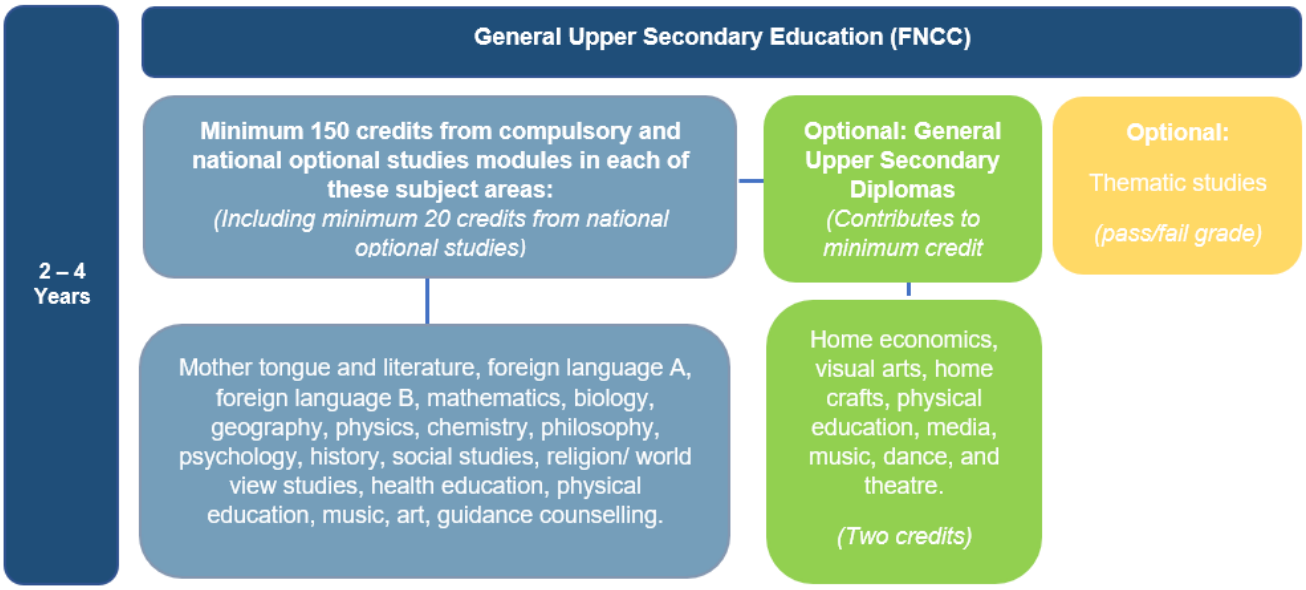


Figure 6: Structural overview of the FNCC/GUSE



In terms of similarities in the programme structure and subjects taught, both programmes follow a baccalaureate-style approach (prioritising breadth) and both programmes contain many similar subjects in their programmes of study. However, whilst the DP separates subjects into subject groups, from which students typically must choose only one option, FNCC/GUSE stipulates that students take modules from all eighteen subject areas listed above. Subjects common to both the DP and FNCC/GUSE include languages (including a variety of classical and modern languages), history, science, maths, arts, geography, and physical education. Additionally, both programmes include social, religious and further humanities subjects.

Regarding differences in the structure of the programme of study, DP students can study most of the six chosen disciplines at two levels: SL (standard level) and HL (higher level). This division in levels is not offered on the same scale in FNCC; only studies in the second national language, foreign languages and mathematics are offered at advanced level.[90] Another difference between the programmes is in the number of subjects that students need to study

[90] Finnish National Authority for Education. (2019). *NCC for General Upper Secondary Education*.

to achieve the diploma or complete the entire FNCC syllabus. In the DP, students must complete the six subjects, with up to four at higher level. In FNCC/GUSE, students must earn a minimum of 150 credits, including a minimum of 20 national optional credits; plus, compulsory credits must be studied from each of the eighteen subject areas listed above, as well as potential optional studies, thematic studies, and general upper secondary diplomas, resulting in a much broader curriculum that the DP.

In terms of general structure and programme duration, the DP is more prescriptive. Students study subjects concurrently and for two years, whereas students of FNCC/GUSE can take two to four years based on their progress, with no stipulation made in the FNCC/GUSE regarding concurrent study. FNCC/GUSE students also design their own curriculum in terms of modules studied in each subject and, thus, there are no grade-specific classes. Whereas the DP programme outlines the teaching hours of individual subjects, the FNCC for GUSE describes the length of study by suggested teaching time per study credit; the flexibility of FNCC means that alterations to designated teaching time can also be made in the local curriculum. The recommended teaching hours per subject, as outlined in the DP curriculum documentation, are 150 at standard level and 240 at higher level.[91] Each credit in FNCC/GUSE should comprise fourteen hours and fifteen minutes of teaching time, in addition to independent study.[92]

Another difference between the two programmes is the requirement to complete additional components. In order to pass the DP, students must complete the 'DP core', which includes TOK, CAS and the extended essay. Those components are only evident in the DP and the FNCC does not include any similar courses or activities. FNCC/GUSE includes the option to study additional general upper secondary diplomas in subjects that allow the student to 'give a long-term demonstration of particular competence and interest'.[93] Subjects in which students may complete diplomas include home economics, visual arts, crafts, physical education, media, music, dance and theatre. Notably, similar optional qualifications which are focused on assessing student's competence and independent interest in these topic areas are not included in the DP.

As an alternative to FNCC/GUSE, Finnish students may choose to pursue vocational education and training (VET). Students may combine a variety of vocational studies and activities with elements of FNCC study units.[94] As a result, students who have completed VET are also eligible to sit the matriculation examination and progress to further or higher education with other FNCC/GUSE students. A similar course is not offered in the DP, though the IB's Career-Related Programme (CP) gives students a vocational pathway through their upper-secondary education.

[91] International Baccalaureate. (2021). *Curriculum*. Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/
[92] Ministry of Education and Culture, Finland. (2018). *Government Decree on General Upper Secondary Education (810/2018).*
[93] Finnish National Authority for Education. (2019). *NCC for General Upper Secondary Education*. p. 430.
[94] European Centre for the Development of Vocational Training (CEDEFOP). (2019). *Vocational education and training in Finland.*

4.4 Requirements and Associated Outcomes

There are no formal entrance requirements stipulated for the DP as the IB envisages numerous educational pathways leading to upper secondary education.[95] However, the IB recommends consulting the subject guides prior to enrolment to ensure an adequate understanding of programme expectations.[96] There is a similar level of flexibility regarding requirements to enter GUSE in Finland. Whilst 'the key criterion for admission is that the student has completed the comprehensive school syllabus', any student with an equivalent completed syllabus and sufficient potential is eligible to apply for GUSE. However, an education provider may issue additional selection criteria, such as entrance exams.[97]

In terms of associated outcomes, according to the DP documentation, although the DP is conceived as a preparatory programme for university matriculation and higher education focusing primarily on rigorous academic study, the programme can also prepare students for employment. Similarly, the FNCC for GUSE states that the principal objective of the most recent education reform in Finland is to increase numbers of those with higher education. FNCC is therefore designed to develop the knowledge and abilities essential for facilitating progression to higher education.[98] Although not a key concern of the objectives of the FNCC, there are references made to the co-operation of education providers with the world of work,[99] and certain modules of study reference gaining familiarity with employment options.[100] Moreover, the personal plan students must complete to guide their studies must contain a career plan, suggesting that this is considered at length.[101]

The DP intends for students to work towards a diploma at the end of the two-year period of study, while the objective of FNCC/GUSE is to gain a General Upper Secondary School Leaving Certificate. In order to achieve the DP, students must achieve a minimum pass grade of 3 in all subjects studied. Similarly, in order to receive the certificate, FNCC/GUSE students must successfully complete the designated subject syllabi from each study unit whilst acquiring a minimum of 150 credits. In order to pass a study unit, students must pass most of the modules within it, as dictated in the FNCC. Students are then graded by their teachers and must achieve a grade 5 or above in order to pass the subject. In addition, students commonly sit the Matriculation Examination at the end of their FNCC/GUSE studies, primarily to gain access to university.

Both programmes have flexible options to reward students with some form of certificate or evidence of accomplishment if they do not complete the full requirements of the respective diploma or FNCC syllabus. Students who are leaving secondary school without having met the requirements for the FNCC/GUSE may be granted a Certificate for Completion of a Syllabus or a Certificate of Resignation, depending on the level of study completion. Similarly, in the DP, certificates are awarded to students that have taken individual subjects but not enrolled on the full DP.[102]

[95] International Baccalaureate. (2015). *Diploma Programme. From principles into practice*. p. 5.
[96] Ibid. p. 22.
[97] Ministry of Education and Culture, Finland. (n.d.). *General Upper Secondary Education.*
[98] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*. p. 10.
[99] Ibid. p. 32
[100] Ibid. p. 429
[101] Ibid. p. 33.
[102] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 4.

One final noteworthy difference between the DP and FNCC/GUSE, in terms of associated outcomes, is that DP students who fulfil specific subject grade criteria can be awarded a bilingual Diploma. This option is not available in the FNCC/GUSE, though the programme does require students to study a foreign language and a second language.

4.5 Student Learning Pathways

In terms of learning pathways, both programmes include compulsory and optional elements. See the programme overviews in section 4.1 for further details on subject selection. To understand the levels of optionality and potential specialisation in each programme, it is instructive to look at what an individual student would be able to choose in practice. The following diagrams demonstrate the subject options available to an imagined student who knows that they would like to study physics at university after the completion of their upper secondary studies.

Figure 7: DP imagined pathway for a student wishing to study physics at university

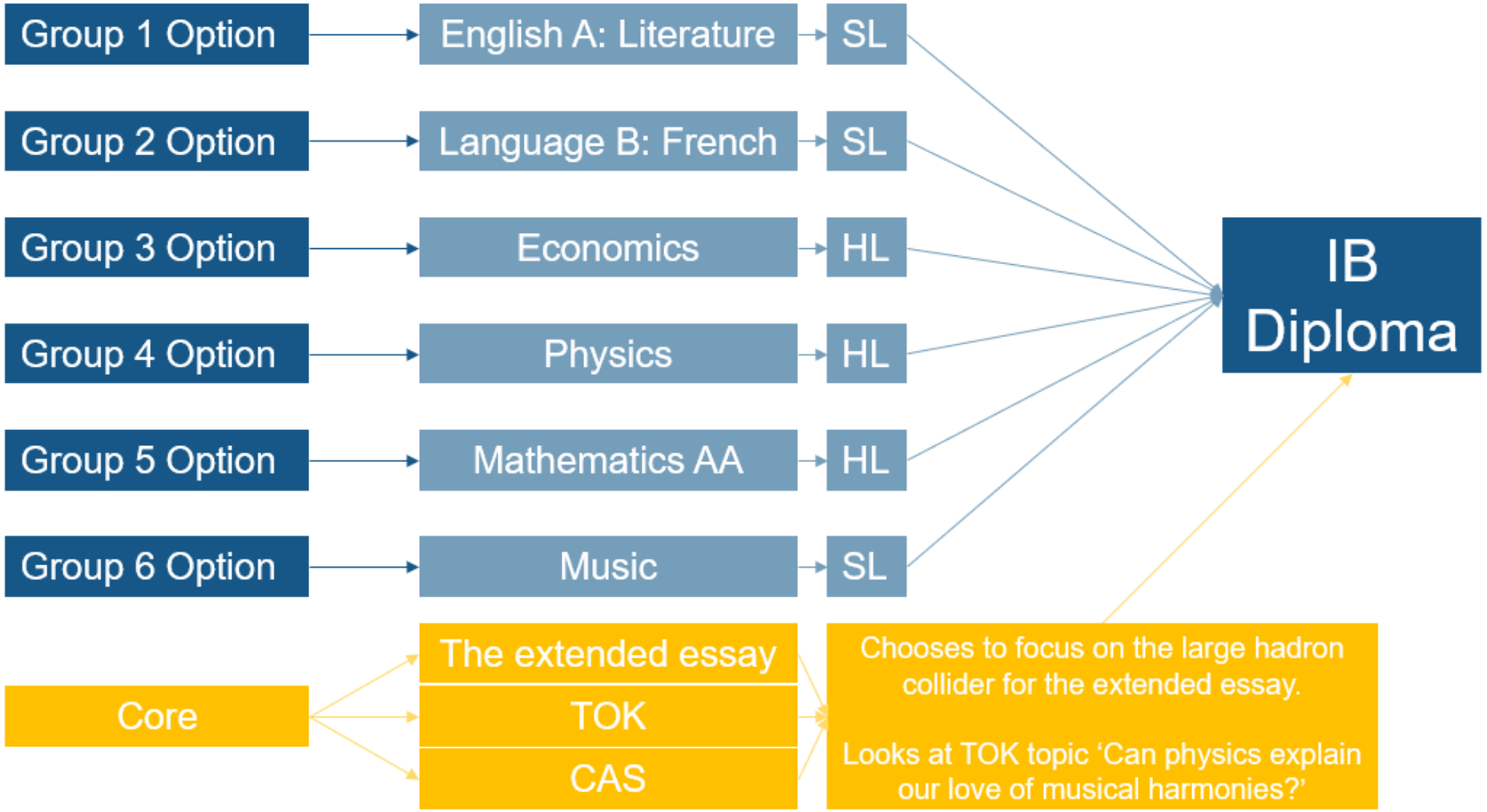
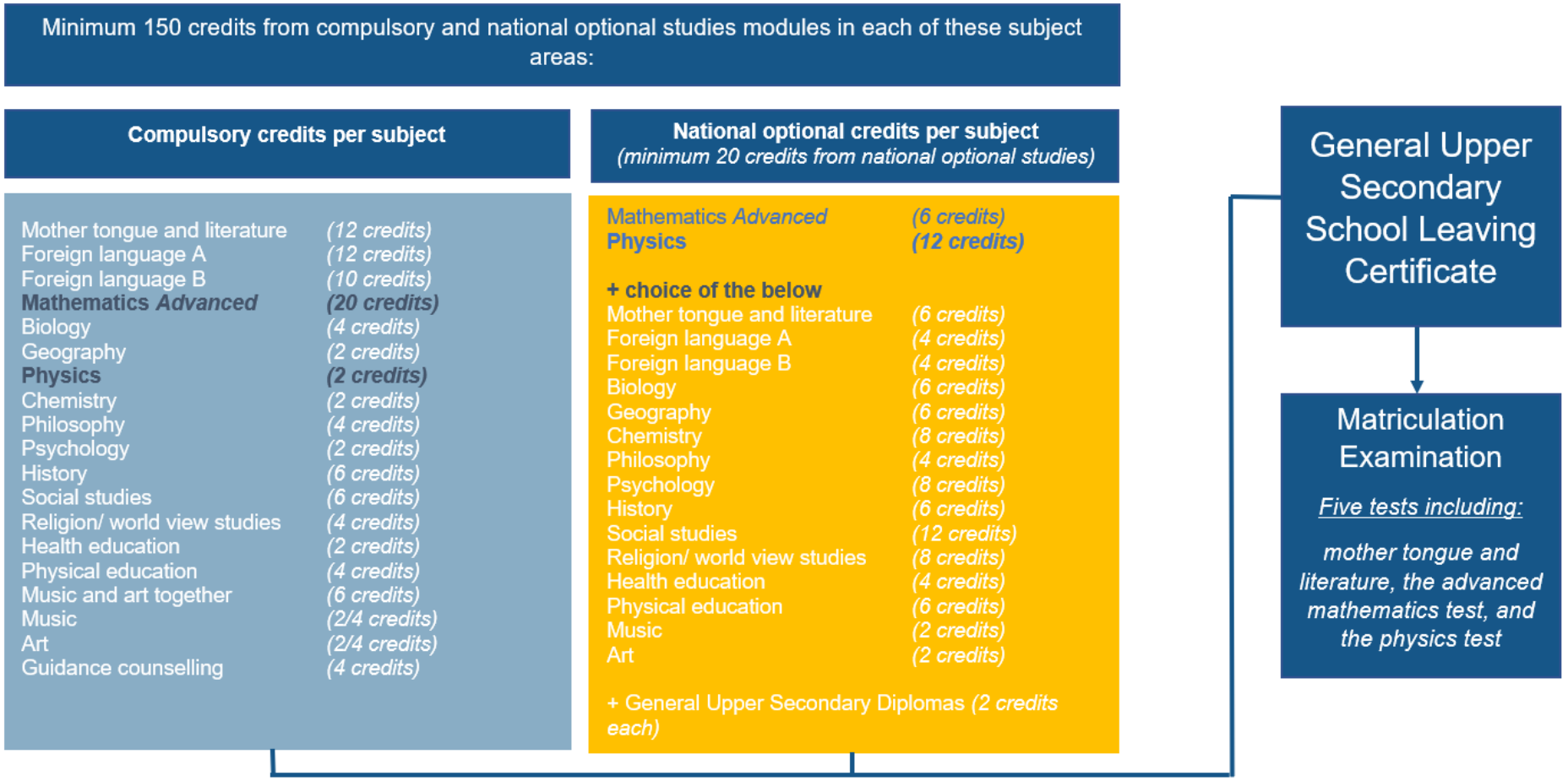


Figure 8: FNCC/GUSE imagined pathway for a student wishing to study physics at university



As can be seen from the diagram above, in the FNCC/GUSE, students will experience a much higher number of subjects than in the DP, with the former featuring 18 compulsory subjects, compared to only six subjects plus the core in the DP. As a result, the FNCC/GUSE has greater breadth than the DP, requiring students to cover a larger number of areas.

Some degree of specialisation in a broad subject area is enabled in the FNCC/GUSE. Students who wish to pursue a somewhat specialised pathway may do so – for example, a student that would like to study physics at university and is mostly interested in science, technology, engineering and mathematics (STEM), although still required to take a number of compulsory credits from humanities and arts subjects, can choose to complete most of their national optional studies in science subjects – e.g. physics, advanced mathematics, chemistry, biology. If both compulsory and national optional studies in these subjects were taken, this would amount to a total of approximately 855h of STEM instruction over two to four years (199.5h for physics, 370.5h for mathematics, 142.5 for biology, and 142.5 for chemistry) – allowing for a relatively high level of specialisation. In this sense, although the Finnish curriculum undoubtedly prioritises breadth, it also allows for considerable depth.

In comparison, the DP also allows for students to specialise in a certain discipline, though the maximum number of STEM subjects they can choose is three. Over the full programme, this amounts to approximately 720h of STEM instruction (e.g. 240h for physics HL, 240h for mathematics AA HL, 240h for chemistry HL).

Overall, both the DP and FNCC/GUSE are baccalaureate-style programmes that promote breadth of learning, but also allow for a degree of specialisation. The main difference between their structure is the number of subjects students experience overall.

4.6 Assessment Methods

This section looks at the key features of assessment in both programmes by using a simple table followed by a short textual description of the key similarities and differences.

Table 13: Top level assessment comparisons

	DP	FNCC/GUSE
External assessment	✓	✗
Weighting	Varies by subject	0%
Mathematics	**SL & HL**: 80%	N/A
Sciences	**SL & HL**: 80%	N/A
Methods	Exam (Typically, two-three exam papers per subject)	N/A
Mathematics	**SL**: 2 papers of 90 minutes in duration each, with 80 marks available in each. **HL**: 3 papers with durations of 120, 120, and 60 minutes. Marks available are 110, 110, and 55. **Question Types**: compulsory short-response and extended response questions, incorporating problem solving in HL paper 3.	N/A
Sciences	**SL**: 3 papers worth 20%, 40%, and 20% of total weighting, with duration of 45, 75, and 60 minutes each. **HL**: 3 papers worth 20%, 36%, and 24% of total weighting, with duration of 60, 135, and 75 minutes each. **Question Types**: multiple choice, short and extended response, data-based and experiment-based; some optionality in paper 3.	N/A
Internal assessment	✓ (Often used)	✓ (Used in all subjects)
Weighting	Varies by subject	100%
Mathematics	**SL & HL**: 20%	100% of final grade determined by a diverse assessment framework, decided in the local curriculum, for both basic and advanced syllabus.
Sciences	**SL & HL**: 20%	100% of final grade determined by a diverse assessment framework, decided in the local curriculum.
Methods	Vary by subject, but should follow IB guidance	Vary by subject but should be both formative and summative, designed around subject specific objectives and module contents.
Mathematics	**SL & HL**: A 'mathematical exploration' involving a piece of written work for 20 marks.	Combination of approaches designed by schools and teachers.
Sciences	A practical, individual investigation with 10 hours duration and 6-12 pages of write-up.	Combination of approaches designed by schools and teachers.

This table shows substantial differences in the overall approach to assessment methods. The DP prioritises external assessment in the form of exams, whilst internal assessment only accounts for 20-30% of the final mark in each subject.[103] On the other hand, the GUSE system relies entirely on flexible methods of internal assessment, in all subjects. Providers of FNCC are advised to use both formative and summative assessment to provide feedback on the attainment of subject specific objectives. Details of assessment are determined in the local curriculum, with the marking and grading of study units decided by teaching staff. An exception is the assessment of oral language skills, for a second national or foreign language, which are not only teacher-assessed throughout the course but also through an additional assessment produced externally by EDUFI.[104]

Despite the flexibility implied by the FNCC, assessment methods in GUSE are still intended to relate to the broad subject specific objectives and competences outlined in the document. For this reason, there is a likelihood that there would be substantial alignment with the DP subjects in terms of assessment types used. Indeed, there are similarities between internal assessment methods in the DP and those alluded to in the FNCC for GUSE. These include laboratory work in sciences, oral work in languages and performances in the arts subjects.[105] However, the level of alignment is hard to conclusively judge due to the high level of flexibility within the FNCC's approach to assessment.

As FNCC subject assessment is based on flexible internal assessment, comparisons with the question types and other aspects of the assessment structure of the DP are challenging. Whilst the DP uses clear assessment objectives to demonstrate the nature and proportional importance of the skills assessed, the FNCC for GUSE merely makes suggestions as to some key subject-related skills and competences that should be assessed as part of the assessment framework decided in the local curriculum.

Although the specifics of the assessment objectives and curriculum design are to be decided by Finnish education providers, some information about assessment is provided in the FNCC under the 'general objectives of instruction' and 'assessment framework' sections of each subject.

Table 14: Comparison of DP assessment objectives and FNCC general objectives of instructions and assessment frameworks[106]

DP subject	DP assessment objectives	FNCC mathematics
DP mathematics subjects	AO1 – knowledge and understanding	'build a mathematical foundation for their further studies'
	AO2 – problem solving	'learn to model practical problem situations and employ different response strategies'; 'mathematical thinking and problem-solving skills'
	AO3 – communication and interpretation	'have the ability to follow a mathematical presentation, read a mathematical text, discuss mathematics, substantiate

[103] International Baccalaureate. (2021). *Understanding DP Assessment*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/
[104] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.
[105] International Baccalaureate. (2021) *Assessment and Exams*.; Finnish National Agency for Education (2019) *NCC for General Upper Secondary Education*.
[106] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education*.

		arguments, and evaluate information provided in different forms'
	AO4 – technology	'use appropriate mathematical methods, software, and information sources, and understand that a solution produced by software is not enough on its own to prove, substantiate, or justify an argument.'
	AO5 – reasoning	'learn to trust their mathematical abilities, skills, and thinking'; 'process data in a mathematical way and become accustomed to making assumptions, investigating their correctness, constructing arguments, and evaluating their soundness and the extent to which the results can be generalised'
	AO6 – inquiry approaches	'using experimental and investigative actions, finding solutions, and presenting them clearly'

DP subject	DP assessment objectives	FNCC physics	FNCC chemistry	FNCC biology
DP science subjects	AO1 – demonstrate knowledge	'gain sufficient knowledge for further studies in natural sciences and fields that use physics'; 'are able to use key concepts in physics logically and in correct contexts'	'obtain sufficient knowledge for further studies in natural sciences and in the fields that apply to chemistry' 'are able to use and employ key concepts in chemistry'	'know how to use key concepts in biology accurately and in correct contexts' 'demonstrations of knowledge and skills'
	AO2 – understanding and application	'study the applications of physics in diverse situations, such as in nature, industries, organisations, and scientific communities'; 'Knowledge of physics and its application'	'become familiar with the applications of chemistry' 'applying their knowledge in chemistry' 'ability to apply chemical information'	'understand the significant of biological knowledge and the applications based on this knowledge for innovations and for solving different problems' 'understand, apply, analyse, evaluate, and present biological information in different situations'
	AO3 – analyse, evaluate, and synthesize	'gain skills in participating in debates and decision-making about the environment and technology'; 'know how to use diverse information sources and evaluate them critically with the help of their	'are able to evaluate the solutions provided by chemistry and the technologies related to it as well as their significance for the individual, the environment and society' 'are able to use diverse information	'use and evaluate critically sources of biological information, and express and justify different views in a way that is characteristic for biology' 'understand, apply, analyse, evaluate, and present biological

		knowledge in physics'	sources and critically evaluate information presented in different contexts'	information in different situations' 'conceptual and methodological competence.'
	AO4 – investigation skills	'are able to formulate questions about the phenomena being observed and develop the questions further into starting points for research, problem-solving or other activity' 'are able to process, interpret, and present research results and evaluate them and the entire research process.'	'are able to formulate questions about the phenomena being observed and develop the questions further into starting points for research and problem-solving' 'know how to process, interpret, and present research results and analyse and evaluate them and the whole research process.'	'conceptual and methodological competence.' 'reflection, justification, and research skills'

As can be seen from these tables, many of the same skills are seemingly assessed in both the DP and FNCC mathematics and sciences subjects. The table demonstrates that both programmes are recognising the importance of a foundation of knowledge and understanding but are seeking with their assessment to evaluate how students can use, explore, and articulate that understanding. Thus, although there may be significant differences in the methods of assessment used in the DP and the FNCC/GUSE, the skills-based criteria for assessment show broad alignment.

In the same way as the DP, a numerical grading system is used in FNCC/GUSE, with a minimum grade required to pass a study unit. Although no universal official pass mark or percentage is recommended by the FNCC, grading is calculated by education providers using 'an arithmetic average weighted by the credits obtained by the student in compulsory and national optional studies'.[107] The grading system is as follows:

- grade 4 – *failed*
- grade 5 – *adequate*
- grade 6 – *moderate*
- grade 7 – *satisfactory*
- grade 8 – *good*
- grade 9 – *very good*
- grade 10 – *excellent*

As already identified, a key difference between the DP and FNCC/GUSE is the absence of external assessment requirements in FNCC/GUSE. Although not a compulsory component of FNCC/GUSE, many students complete their studies with the standardised, externally marked, Matriculation Examination to demonstrate knowledge acquired and become eligible for access

[107] Ibid. p. 61.

to higher education. As part of the examination, students must complete five tests from different subject groups. Studies in the mother tongue and literature are compulsory, as well an additional four tests from three of the following groups: mathematics, a second national language, foreign languages and humanities and natural sciences. Unlike the final DP examinations, the matriculation examination is separate from FNCC/GUSE, yet there are similarities between the structure of the subject groups of the matriculation exam and the six subject groups that form part of the DP; notably, the focus on language and literature, additional languages, mathematics, humanities and sciences. Another stipulation of the matriculation exam is that one test must be taken at advanced syllabus level, which is similar to the DP requirement for a minimum number of higher-level studies; though only second national language, foreign languages and mathematics are offered at advanced level.[108]

Overall, there is significant variation in the structure of assessment objectives and flexibility of assessment methods between the DP and FNCC/GUSE. Despite this, similar priorities are placed by both programmes on a comparable range of skills.

[108] Finnish National Authority for Education. (2019). *NCC for General Upper Secondary Education*.

5. Subject-Level Alignment

This section focuses on answering RQ3 and the sub-questions associated to it, namely:

Table 15: Research question 3

RQ3: To what degree do the subjects align with regard to: 3.1: Content • Topics (i.e. scope of content area, breadth depth) • Learning activities (i.e. difficulty, demand). 3.2: Expected learning outcomes • Knowledge • Competencies (i.e. subject-specific, 21st century competencies).

For each subject area, there is a brief introduction to the subjects being compared, followed by an overview of the findings from the comparative analysis between the DP subjects and the FNCC comparison points regarding learning outcomes, content, and demand.

5.1 Mathematics

The following is the list of subjects used in the mathematics subject comparison analysis.

Mathematics: analysis and approaches[109]
Mathematics: analysis and approaches (AA) is a subject option from the mathematics group in the DP curriculum – offered at both SL and HL. This subject is intended for students who are interested in both real and abstract applications of mathematical concepts and enjoy problem solving and generalisation. SL is suitable for students who want to study a good level of mathematics, but not at an advanced level. Therefore, SL prepares students for further study in areas involving mathematical elements, such as geography. HL is suitable for students who want an in-depth study of mathematics and enjoy solving challenging problems. Therefore, HL prepares students for further study in mathematics, as well as other areas with a strong mathematical focus, such as physics and engineering.

Mathematics: applications and interpretation[110]
Mathematics: applications and interpretation (AI) is a subject option from the mathematics group in the DP curriculum – offered at both SL and HL. This subject is intended for students who are interested in exploring more practical applications of mathematics and would enjoy using mathematical models and technology. SL is most suitable for those who want to obtain a good level of knowledge of mathematics, with a focus on real-world applications. Therefore, SL prepares students for further study in areas with some practical mathematics elements, such as biology and business. HL is suitable for students wishing to gain more in-depth knowledge of mathematics, with a focus on real-world situations and the applications of mathematics.

[109] International Baccalaureate. (2019). *Mathematics: analysis and approaches guide*.
[110] International Baccalaureate. (2019). *Mathematics: applications and interpretation guide.*

Basic syllabus[111]
The basic syllabus is one of two options offered by Finland's national curriculum for general upper-secondary mathematics education. The syllabus is comprised of seven compulsory modules, worth 12 credits, and two optional modules, worth four credits. Through focusing on applications of mathematics, such as modelling, finance, and statistics, this syllabus equips students with the knowledge and skills for everyday life and will support further studies for which a grounding in basic mathematical concepts will be beneficial.

Advanced syllabus[112]
The advanced syllabus is one of two options offered by Finland's national curriculum for general upper-secondary mathematics education. The syllabus is comprised of nine compulsory modules, worth 20 credits, and three optional modules, worth six credits. This syllabus focuses more on pure mathematics than the basic syllabus and goes into further depth and complexity in its topics. Therefore, this option is suitable for students with good mathematical ability, who may require more advanced mathematical knowledge in their future studies and careers.

5.1.1 Learning Outcomes – Mathematics

For its mathematics learning outcomes, the DP sets out aims and assessment objectives for all subjects within the mathematics subject group – hence the extracted themes are the same for mathematics: analysis and approaches and mathematics applications and interpretation. Similarly, Finland's curriculum sets out the same outcomes for both its basic and advanced syllabi. Finland's mathematics-specific learning outcomes take the form of 'general objectives', 'transversal competencies' (contextualised for mathematics), and a section describing the 'task of the subject'.

The following summary table demonstrates the learning outcome themes that were extracted from the DP mathematics and indicates if and where they were judged to have presence within the learning outcomes of the FNCC mathematics curricula.

Table 16: Presence of the DP mathematics subject group learning outcome themes in the FNCC

Themes extracted from the learning outcomes in the DP mathematics subject group	Presence in the FNCC	
1. Being aware of, and engaging with, mathematics in its wider context		Present in the general objectives, transversal competencies, and task of the subject. Specifically, the 'societal, ethical, and environmental', and 'global and cultural' competencies strongly demonstrate this theme.
2. Developing learning skills; having a positive and resilient attitude, working both independently and collaboratively, being reflective and evaluating work		Present in the general objectives and transversal competencies – specifically the 'well-being' and 'interaction' competencies.

[111] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.*
[112] Ibid.

3. Using inquiry-based approaches		Present in the general objectives, where use of experimental and investigative actions are described.
4. Understanding the concepts, principles and nature of mathematics and applying concepts and procedures to a range of contexts		Present mainly in the task of the subject, which describes understanding and application. Also implied in other outcomes, such as those relating to modelling and environmental contexts.
5. Making links and generalisations		Present in the general objectives, transversal competencies, and the task of the subject. Specifically, the 'multidisciplinary and creative competency' strongly demonstrates this theme.
6. Developing critical/creative thinking skills e.g. problem-solving and reasoning		Present in the general objectives, transversal competencies, and task of the subject. Problem-solving, reasoning, evaluation, and modelling, are frequently referenced.
7. Communicating mathematics clearly and in various forms		Present in the general objectives and the task of the subject. Students are expected to be able to understand and communicate mathematics taking different forms.
8. Knowing how technology and math influence each other and using technology to develop ideas and solve problems		Present in the task of the subject. Students are expected to use technology, as well as to evaluate it.

Key:

	This theme is well-evidenced in the learning outcomes of the FNCC.		*This theme is partially evidenced in the learning outcomes of the FNCC.*		*This theme is not evident in the learning outcomes of the FNCC.*

Presence of the DP's Learning Outcome Themes

As demonstrated in the table above, all of the DP's themes are present in Finland's mathematics learning outcomes. Similarly, to the DP, Finland expects students to understand and apply mathematics in wider contexts, including societal, ethical, environmental, global, and cultural. For example, the 'global and cultural' transversal competence expects students to 'appreciate the significance of mathematics for different cultures and in the development of history, and to understand its nature as a universal language'.[113] Moreover, it is expected that students will reflect on how they can use mathematical skills to solve problems relating to humankind and the environment, thus demonstrating the 'societal, ethical, and environmental' transversal competency. Overall, these expectations of appreciating different perspectives, gaining awareness of ethical, environmental, and societal issues, and exploring mathematics solutions to these strongly echo the aims of DP mathematics.

Furthermore, the transversal competencies also demonstrate other DP themes. The 'multidisciplinary and creative' competence speaks to students understanding how mathematical concepts are connected to each other and with other subjects, thus this reflects

[113] Ibid. *6.6 Mathematics.*

the DP's theme of a similar nature regarding making links to other disciplines. In addition, the transversal competencies of interaction and well-being correlate with the DP's theme of the development of learning skills. Indeed, these competencies describe building students' confidence, independence, and perseverance, as well as developing decision-making, collaboration, and interaction skills.

Another strongly demonstrated DP theme is that of critical and creative thinking skills. All the elements of Finland's learning outcomes reference this theme, specifically they describe problem-solving, evaluating mathematical information and the soundness of results, constructing and substantiating mathematical arguments, creative thinking, and modelling.

Together, the general objectives and task of the subject encompass the rest of the DP's themes. Like the DP, the FNCC aims to encourage students to use inquiry-based approaches, specifically it states that students should 'become confident in using experimental and investigative actions, finding solutions, and presenting them clearly'.[114] Furthermore, communication skills are also demonstrated, as the task of the subject describes students being able to communicate mathematics, using the language of mathematics in spoken, written and other forms. The task of the subject section also describes the use of technology, which, similarly to the DP, expects students to utilise technology in research, exploration, problem-solving, and to evaluate its reasonableness and limitations. Finally, understanding and application of mathematics is implied in various other themes and explicitly referenced in the task of the subject.

Overall, the DP's themes are strongly present in the FNCC, often with similar wording and emphasis.

Other Themes in the FNCC

In general, there are no significant themes that are not present in the DP. However, it can be noted that Finland's curriculum learning outcomes made more explicit reference to modelling and making connections within the subject of mathematics.

Summary

Overall, there is strong alignment between the learning outcomes of the DP's mathematics subjects and Finland's. Both the DP and FNCC take a holistic approach and similarly emphasise critical and creative thinking, use of inquiry-based approaches, building transferable learning skills, and developing awareness of the wider contexts of mathematics.

5.1.2 Content – Mathematics

This section compares and contrasts the content of the DP and FNCC curricula falling within the category of mathematics. In order to support visual comparison at-a-glance, the DP and FNCC mathematics curricula are presented below in diagrams which show the key topics and sub-topics (where available) included in each.

[114] Ibid.

Figure 9: DP mathematics: analysis and approaches content visualiser

	Standard level topics	Additional higher level topics
Topic 1 Number and algebra	1.1 Standard form; 1.2 Arithmetic sequences and series; 1.3 Geometric sequences and series; 1.4 Financial applications and geometric sequences and series; 1.5 Integer exponents and intro to logarithms; 1.6 Simple proof; 1.7 Rational exponents and laws of logarithms; 1.8 Sum of infinite convergent geometric sequences; 1.9 Binomial theorem (natural number)	1.10 Counting principles and extended binomial theorem; 1.11 Partial fractions; 1.12 Complex numbers intro; 1.13 Polar and Euler form; 1.14 Complex roots, De Moivre's theorem and powers/roots of complex numbers; 1.15 Proof by counter example, contradiction, and induction; 1.16 Solutions of systems of linear equations
Topic 2 Functions	2.1 Gradients and equations of straight lines; 2.2 Intro to functions; 2.3 Graphing functions; 2.4 Key features of graphs; 2.5 Composite, identity, and inverse functions; 2.6 Quadratic functions; 2.7 Solving quadratic equations and inequalities & the discriminant; 2.8 Reciprocal and rational functions; 2.9 Exponential and logarithmic functions; 2.10 Graphical and analytical solutions; 2.11 Transformations	2.12 Polynomial functions; 2.13 Harder rational functions; 2.14 Odd, even, and inverse functions; 2.15 Graphical and analytical solutions of inequalities; 2.16 Further graphs, including modulus and solutions
Topic 3 Geometry and trigonometry	3.1 Geometry recap; 3.2 Trigonometry recap; 3.3 Applications and diagrams; 3.4 Circles and radians; 3.5 Definitions, exact values, and sine rule for ambiguous case; 3.6 Identities and relationships; 3.7 Functions and transformations of sin, cos, and tan; 3.8 Solving trigonometric equations graphically and analytically	3.9 Reciprocal trigonometric ratios, identities, and inverse functions; 3.10 Compound angle identities and double angle for tan; 3.11 Symmetry properties; 3.12 Intro to vectors; 3.13 Scalar product and application; 3.14 Vector equation of a line and application; 3.15 Coincident, parallel, skew, and intersecting lines; 3.16 Cross product of vectors; 3.17 Planes; 3.18 Intersections and angles (planes)
Topic 4 Statistics and probability	4.1 Sampling; 4.2 Presenting data (tables, histograms, cumulative freq.); 4.3 Measures of central tendency and dispersion; 4.4 Correlation and regression line; 4.5 Intro to probability; 4.6 Diagrams, conditional probability, combined or independent events; 4.7 Discrete random variables; 4.8 Binomial distribution; 4.9 Normal distribution; 4.10 Equation of regression line of x on y; 4.11 Formulae for conditional probabilities and independent events; 4.12 Standardisation of normal variables (z-values)	4.13 Bayes' theorem; 4.14 Continuous random variables
Topic 5 Calculus	5.1 Intro to limits and derivatives; 5.2 Increasing and decreasing functions; 5.3 Derivative of $f(x)=ax^n$; 5.4 Tangents and normal; 5.5 Definite integrals; 5.6 More derivatives and use of product, chain, and quotient rules; 5.7 The second derivative; 5.8 Maximum, minimum and inflection points, and optimization; 5.9 Kinematic problems; 5.10 Indefinite integrals and integration by inspection and substitution; 5.11 Definite integrals and area of a curve	5.12 Continuity, differentiability, limits, and higher derivatives; 5.13 Evaluation of limits and L'hopitals rule; 5.14 Implicit differentiation; 5.15 Further derivatives and indefinite integrals; 5.16 Integration by substitution and by parts; 5.17 Volumes of revolution; 5.18 First order differential equations; 5.19 Maclaurin series
The toolkit and mathematical exploration	The exploration is a piece of written work that involves investigating an area of mathematics.	

Figure 10: DP mathematics: applications and interpretation content visualiser

	Standard level topics	Additional higher level topics
Topic 1 Number and algebra	1.1 Standard form; 1.2 Arithmetic sequences and series; 1.3 Geometric sequences and series; 1.4 Financial applications of geometric sequences and series; 1.5 Integer exponents and intro to logarithms; 1.6 Approximation, estimation, bounds and errors; 1.7 Amortization and annuities using technology; 1.8 Using technology to solve systems of equations and polynomials	1.9 Laws of logarithms; 1.10 Rational exponents; 1.11 The sum of infinite geometric sequences; 1.12 Complex numbers; 1.13 Euler and Polar form; 1.14 Matrices; 1.15 Eigenvalues and eigenvectors
Topic 2 Functions	2.1 Gradients and equations of straight lines; 2.2 Intro to functions; 2.3 Graphing functions; 2.4 Key features of graphs; 2.5 Modelling with functions; 2.6 Modelling skills	2.7 Composite and inverse functions; 2.8 Transformations; 2.9 Modelling further functions; 2.10 Using logarithms to scale numbers and linearize data
Topic 3 Geometry and trigonometry	3.1 Geometry recap; 3.2 Trigonometry recap; 3.3 Applications and diagrams; 3.4 Circles, sectors, and arcs; 3.5 Equations of perpendicular bisectors; 3.6 Voronoi diagrams	3.7 Radians; 3.8 Sin, Cos, Tan definitions, and Pythagorean identity; 3.9 Matrix transformations; 3.10 Vectors introduction and notation; 3.11 Vector equation of a line; 3.12 Vector application to kinematics; 3.13 Scalar and cross product; 3.14 Graph theory and simple, directed and subgraphs; 3.15 Adjacency matrices and weighted adjacency tables; 3.16 Decision math
Topic 4 Statistics and probability	4.1 Sampling; 4.2 Presenting data (tables, histograms, cumulative freq.); 4.3 Measures of central tendency and dispersion; 4.4 Correlation and regression line; 4.5 Intro to probability; 4.6 Diagrams, conditional probability, combined or independent events; 4.7 Discrete random variables; 4.8 Binomial distribution; 4.9 Normal distribution; 4.10 Spearman's rank; 4.11 Hypothesis testing, chi-squared and t-tests	4.12 Collecting and organising data and testing for reliability and validity; 4.13 Regression, residuals, coefficient of determination; 4.14 Linear transformations, linear combinations, unbiased estimations; 4.15 Central Limit theorem; 4.16 Confidence Intervals; 4.17 Poisson Distribution; 4.18 Further hypothesis testing; 4.19 Transition matrices and Markov chains
Topic 5 Calculus	5.1 Intro to limits and derivatives; 5.2 Increasing and decreasing functions; 5.3 Derivative of $f(x)=ax^n$; 5.4 Tangents and normal; 5.5 Definite integrals; 5.6 Maximum and minimum points; 5.7 Optimisation; 5.8 Area using trapezoidal rule	5.9 More derivatives and the chain, product, and quotient rule; 5.10 Second derivatives; 5.11 Finding further integrals and integration by inspection and substitution; 5.12 Area of a region and volumes of revolution; 5.13 Kinematic problems; 5.14 Differential equations; 5.15 Slope fields and their diagrams; 5.16 Euler's method and numerical solutions to differential equations and coupled systems; 5.17 Phase portraits; 5.18 Simple second order differential equations
The toolkit and mathematical exploration	The exploration is a piece of written work that involves investigating an area of mathematics.	

Figure 11: FNCC mathematics content visualiser

Basic syllabus	Compulsory	MAY1 Numbers and equations (2 credits)	MAB2 Expressions and equations (2 credits)	MAB3 Geometry (2 credits)	MAB4 Mathematical models (2 credits)	MAB5 Statistics and probability (2 credits)	MAB6 Elements of mathematical economics (1 credit)	MAB7 Mathematical economics (1 credit)		
	Optional	MAB8 Mathematical analysis (2 credits)	MAB9 Statistical and probability distributions (2 credits)							
Advanced syllabus	Compulsory	MAY1 Numbers and equations (2 credits)	MAA2 Functions and equations 1 (3 credits)	MAA3 Geometry (2 credits)	MAA4 Analytical geometry and vectors (3 credits)	MAA5 Functions and equations 2 (2 credits)	MAA6 Derivative (3 credits)	MAA7 Integral calculus (2 credits)	MAA8 Statistics and probability (2 credits)	MAA9 Mathematical economics (1 credit)
	Optional	MAA10 3D geometry (2 credits)	MAA11 Algorithm and number theory (2 credits)	MAA12 Analysis and continuous distribution (2 credits)						

Structure

In a similar way to SL and HL in DP mathematics, Finland's curriculum offers two syllabi of different levels – basic and advanced – from which one is chosen. The basic syllabus aims to give a good grounding in mathematics, whilst the advanced offers more in-depth study for students who are able and may need mathematics in further education. However, the important difference is that the advanced syllabus does not follow on from the basic syllabus in the way that AHL content follows on from SL content. Indeed, the basic and advanced syllabi are separate, with students usually completing one of them – though it is possible for students to change from one to the other. Furthermore, unlike the DP, Finland's national curriculum does not offer syllabi which take a specific thematic focus, as AA and AI do in the DP.

Whilst DP mathematics subjects are broken down into five main topics, which remain the same for both SL and HL, Finland's syllabi are broken down into smaller topics, called modules, and are different for basic and advanced – except for one common topic, MAY1 Numbers and equations. Furthermore, each topic is worth a number of credits, with some being compulsory and others optional. The basic syllabus has 12 compulsory credits and 4 optional credits, the advanced syllabus has 20 compulsory credits and 6 optional credits. There is no minimum requirement for optional credits specific to mathematics, however, students must complete a minimum of 20 optional credits in general upper-secondary education. This is different from the DP, which offers no optional topics; hence, Finland's curriculum offers an element of flexibility which the DP does not.

Content Alignment

The figures below show a simplified summary of the extent to which FNCC mathematics aligns with the main topics of the DP's subjects.

Figure 12: Summary of the content alignment FNCC has with the main topics in AA

AA topics		Presence in FNCC	
		Basic	Advanced
SL	1. Number and algebra		
	2. Functions		
	3. Geometry and trigonometry		
	4. Statistics and probability		
	5. Calculus		
AHL	1. Number and algebra		
	2. Functions		
	3. Geometry and trigonometry		Majority of vector content is part of an optional credit
	4. Statistics and probability		Optional credit
	5. Calculus		

Figure 13: Summary of the content alignment the FNCC has with the main topics in AI

AI topics		Presence in FNCC	
		Basic	Advanced
SL	1. Number and algebra		
	2. Functions		
	3. Geometry and trigonometry		
	4. Statistics and probability		
	5. Calculus	Optional credit only	
AHL	1. Number and algebra		
	2. Functions		
	3. Geometry and trigonometry		
	4. Statistics and probability		
	5. Calculus		

* Where applicable, content alignments found in pre-requisite subjects are carried forwards and combined with new alignments to represent the cumulative content covered.

Key:

	Strong presence of this topic in the FNCC.		*Partial presence of this topic in the FNCC.*		*Little or no presence of this topic in the FNCC.*	N/A	*This topic does not exist at the respective level.*

Basic syllabus

Mathematics: analysis and approaches

The mapping of content shows that the basic syllabus has some significant alignment with the SL content of AA, though not in every main topic. The SL topic that the basic syllabus has the most alignment with is that of 'Number and algebra'. The basic syllabus covers arithmetic and geometric sequences and series in similar detail – –including financial applications. However, binomial theorem, simple proof, and laws of logarithms are not included.

The basic syllabus is partially aligned with SL 'Functions' content due to its inclusion of quadratic functions and solutions, exponential functions, and graphing of functions. However, rational functions, logarithmic functions, inverse functions, composite functions, and transformations are not present in the syllabus – –though it can be noted that polynomials, which is an AHL sub-topic in AA, is present. Furthermore, the basic syllabus frequently references modelling of functions, similar to AI.

Another topic with which the basic syllabus partially aligns is that of SL 'Statistics and probability', due to the basic syllabus including similar coverage of correlation, linear regression, and probability. More sub-topic alignments are found with the binomial and normal

distributions; however, these are only covered in the national optional credit MAB9. There are a few sub-topic alignments with SL 'Calculus', however, none of this content is compulsory in the basic syllabus – it is offered as national optional credit MAB8. This credit only includes basic calculus content, such as derivatives of polynomials and finding maximum/minimum points. Additionally, geometry and trigonometry content is compulsory, though only aligns with a couple of the more basic sub-topics in AA SL.

Most of the content in the basic syllabus is present in AA, however, compulsory credits MAB6 and MAB7 may offer economics content which is not present in AA, though there will be some overlap with AA's financial sub-topics. Furthermore, the basic syllabus contains some areas which are more typical of AI than AA, such as modelling, confidence intervals, and margins of error–though the latter two only appear in the national optional credit MAB9.

In summary, there is partial alignment with AA SL content and no alignment with AA AHL content. Where there is alignment with SL content, this is most significant in 'Number and algebra', 'Functions', and 'Statistics and probability'. Only a few sub-topic alignments are found for 'Geometry and trigonometry' and 'Calculus' – the latter originating from an optional credit. Overall, AA SL content exceeds the basic syllabus in depth and has greater breadth in its compulsory content.

Mathematics: applications and interpretation

The mapping of content reveals that the basic syllabus generally has partial alignment with the main topics of AI SL content. The basic syllabus is partially aligned with 'Number and algebra' SL content by covering arithmetic and geometric sequences and series in similar detail, but not including amortization and annuities or approximation. For SL 'Functions', the basic syllabus does include a focus on modelling with polynomial and exponential functions, however, this is a smaller range of functions than covered by AI. That said, the content references similar modelling skills such as using technology, evaluating usability of models, making comparisons, and making predictions.

As with AA, there is good alignment with 'Statistics and probability' SL content, with the basic syllabus also including concepts of correlation and regression, probability, goodness-of fit, and probability distributions – though study of the binomial and normal distributions is only part of an optional credit. Additionally, there is partial alignment with SL 'Calculus', due to the inclusion of finding derivatives of polynomials and maximum/minimum points; however, it can be noted that these are only covered in the national optional credit MAB8 and do not include integration or optimisation. The basic syllabus has limited alignment with 'Geometry and trigonometry'–only covering some of the simpler sub-topics.

Mostly, the basic syllabus does not include content which is not present in AI. The only notable additional content is that found in the two compulsory economic credits, however, much of the content of these overlaps with AI financial sub-topics.

Overall, there is partial alignment with AI SL content and no alignment with AHL content. All main topics at SL, except 'Geometry and trigonometry', had partial alignment – though all 'Calculus' content is optional. Therefore, the basic syllabus content has less depth than AI SL and HL, and less breadth in its compulsory content.

The table below summarises the basic syllabus content that is not present in either DP mathematics subjects, or only one of them.

*Table 17: FNCC Basic mathematics content which is not covered in the DP**

Significant content not in AA (only)	Significant content not in AI (only)
• Mathematical models (linear, exponential models, and understanding goodness-of-fit) • Further financial applications • Concepts of confidence intervals and margin of error	
Significant content not in either DP mathematics subject	
• Stronger focus on economic applications	

* Significant content does not include topics which are typically studied *prior* to upper secondary

Advanced syllabus

Mathematics: analysis and approaches

The mapping of content shows that the advanced syllabus has strong alignment with AA SL content and some limited alignment with AHL content. Firstly, alignment with 'Number and algebra' SL content is strong, as the advanced syllabus includes exponentials, logarithms, binomial theorem, and sequences and series. Furthermore, the syllabus also includes combinatorics, thus this aligns with the similar sub-topic in AHL, however, this is the only alignment with AHL in this topic.

The advanced syllabus aligns strongly with 'Functions' SL content due to its coverage of quadratic, exponential, logarithmic, and rational functions. Whilst most SL 'Functions' content is present, transformations and composite functions are not included and finding the inverse of functions only appears within the optional credit MAA11.

Again, most 'Geometry and trigonometry' SL content is present in the advanced syllabus, including volume and surface area, basic trigonometry and Pythagoras, sine and cosine functions, radians, and solving trigonometric equations. However, transformations and composite functions are again not present in this topic. Regarding AHL content, the advanced syllabus covers an introduction to vectors in its compulsory credits and offers further in-depth study in the optional credit MAA10 – which includes the scalar and cross products and finding vector equations of lines and planes. However, the advanced syllabus coverage of vectors does not appear to be as extensive as AA and also does not extend to include reciprocal trigonometric functions and identities other than the Pythagorean identity.

Similarly, there is strong alignment with SL 'Statistics and probability' content, as the advanced syllabus includes central tendency and dispersion, correlation and linear regression, probability, and discrete random variables. The optional credit MA11 also offers study of the normal distribution and continuous random variables, hence this credit creates partial alignment with AA's 'Statistics and probability' AHL content.

Unlike the basic syllabus, studies of calculus are compulsory in the advanced syllabus. These include sub-topics such as derivatives of polynomials and other functions, product and quotient rules, finding maximum and minimum points, definite integrals, and using integration to find area and volume. There is also an optional credit, MAA12, which explores limits and the continuity and differentiability of functions – hence some AHL sub-topics are present. However, a few SL sub-topics are not included, such as the second derivative, kinematic applications, and indefinite integrals. A larger amount of AHL content is also not included, such as differential equations, Maclaurin series, integration methods, and implicit differentiation.

Most advanced syllabus content can be found in AA, with one or two exceptions. The advanced syllabus offers an optional credit, MAA11 'Algorithm and number theory', which includes programming algorithms, concepts of logic, and number theory. This may include some similar concepts to the proof sub-topics in AA, but proof is not stated as a requirement of this optional credit. Furthermore, as with the basic syllabus, there is a stronger focus on modelling and economics in the advanced syllabus than in AA.

In summary, there is strong alignment with AA SL content in all main topics, with the advanced syllabus covering most, though sometimes not all, significant SL sub-topics. Alignment with AA AHL content is considerably weaker, with the most significant alignment originating from the optional module covering vectors. Therefore, the advanced syllabus slightly exceeds AA SL in some areas, though has lesser depth and breadth than AA HL content overall.

Mathematics: applications and interpretation

The mapping of content shows that the advanced syllabus has mostly strong alignment with AI SL content, and partial alignment with AHL content in one main topic. Firstly, some 'Number and algebra' SL sub-topics are present in the advanced syllabus, including arithmetic and geometric sequences and series and financial applications, though it is unclear whether annuities and amortization are included. A few AHL sub-topics are also present, specifically these are laws of exponentials and logarithms.

The advanced syllabus includes the modelling of polynomial, exponential, logarithmic and trigonometric functions, hence there is strong alignment with AI SL content in the topic of 'Functions'. However, there is no alignment with AHL content due to composite functions, transformations, and further complex functions not being covered.

Most SL sub-topics from AI 'Geometry and trigonometry' are present in the advanced syllabus, except Voronoi diagrams. There is also a considerable amount of AHL content which includes vectors, radians, trigonometric functions, and identities. However, it can be noted that some vector content is optional and other AHL sub-topics such as matrix transformations, graph theory, adjacency matrices, and decision mathematics are not included. However, it can be noted that the optional credit MA11 'Algorithms and number theory' may develop some similar concepts involving algorithms.

Furthermore, there is strong alignment with SL 'Statistics and probability', with the advanced syllabus covering central tendency and dispersion, correlation and linear regression, probability, discrete random variables, the binomial distribution, and, as part of an optional credit, the normal distribution. However, Spearman's rank, hypothesis testing, chi-squared tests and goodness of fit do not appear to be included in the syllabus. Also, the advanced

syllabus does not align with the AHL content in this topic, including nonlinear regression, further hypothesis testing, Markov chains, and Poisson distribution. Similarly, the advanced syllabus has strong alignment with SL 'Calculus' content, though does not cover optimisation and most AHL sub-topics, such as differential equations, Euler's method, slope fields, the second derivative, applications to kinematics, and phase portraits.

There are a few areas which are present in the advanced syllabus and not present in AI. Some of these are sub-topics that can be found in AA, such as polynomial and rational functions, counting principles, continuity and differentiability, and continuous random variables – the last two being part of optional credit MAA12. Furthermore, as previously mentioned, the advanced syllabus also includes economics and an optional credit of MA11 'Algorithm and number theory' which has different content from AI.

In summary, the advanced syllabus is well-aligned with SL content, though usually includes most, rather than all, SL sub-topics. Alignment with AHL is mostly limited to some partial alignment in the topic of 'Geometry and trigonometry'. Therefore, the advanced syllabus in some places slightly exceeds the content of SL, though has considerably less depth and breadth than AI HL content.

The table below summarises the advanced syllabus content that is not present in either DP mathematics subjects, or only one of them.

*Table 18: FNCC Advanced mathematics content which is not covered in the DP**

Significant content not in AA (only)	Significant content not in AI (only)
• Mathematical modelling using software • Further financial applications	• Rational functions • Absolute value functions and equations • Continuity of functions • Combinatorics • Limits of functions • Differentiability of functions
Significant content not in either DP mathematics subject	
• Stronger focus on economic applications • Algorithm and number theory – may contain elements which are in AA or AI (such as properties of prime numbers, divisibility, and use of algorithms)	

* Significant content does not include topics which are typically studied *prior* to upper secondary

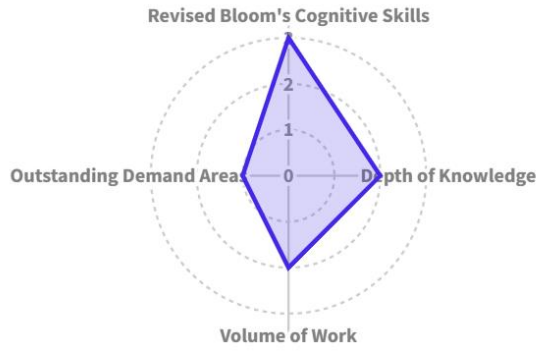
5.1.3 Demand – Mathematics

This section considers the alignment between the DP and FNCC mathematics curricula in terms of demand.

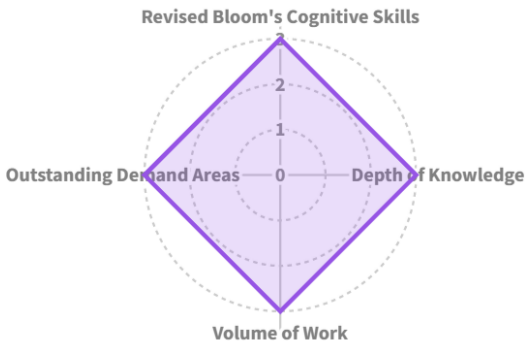
The DP and FNCC curricula were analysed using the same demand tool in order to create a demand profile for AA (SL and HL), AI (SL and HL), FNCC Basic, FNCC Advanced (compulsory) and FNCC Advanced (compulsory and optional). The scores for the advanced syllabus were split into two profiles as the panellists agreed that the scores would slightly differ depending on whether only the compulsory modules were taken, as opposed to all the modules, both compulsory and optional. For the basic syllabus, this split was not deemed necessary and the scores account for all compulsory and optional modules combined. These demand profiles are presented below in the form of radar diagrams, with the last two diagrams showing both DP mathematics subjects and the FNCC profiles superimposed, enabling immediate visual comparison.

Figure 14: Visual representations of subject demand

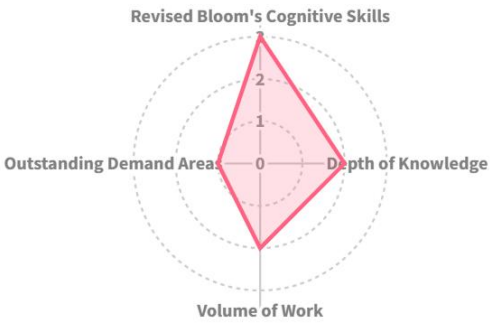
DP mathematics: analysis and approaches SL



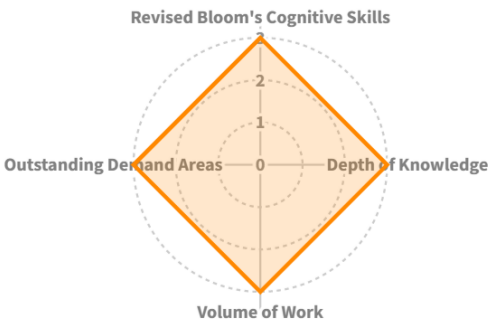
DP mathematics: analysis and approaches HL



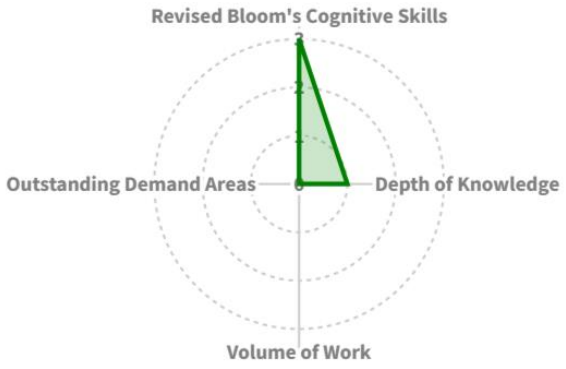
DP mathematics: applications and interpretation SL



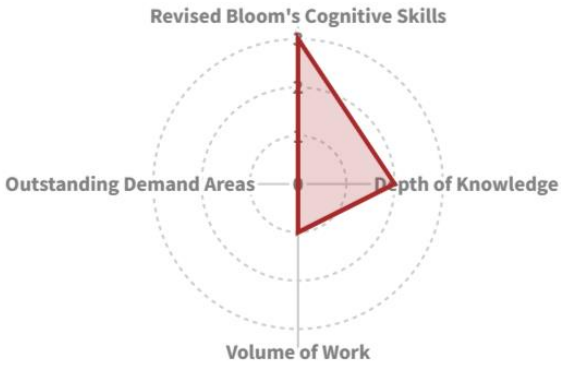
DP mathematics: applications and interpretation HL



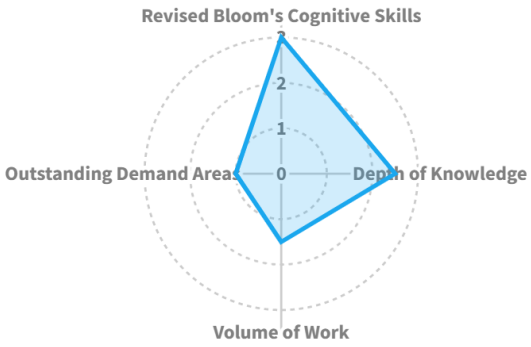
FNCC Basic



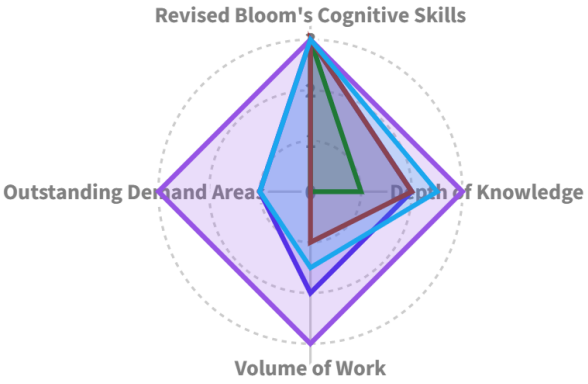
FNCC Advanced (compulsory)



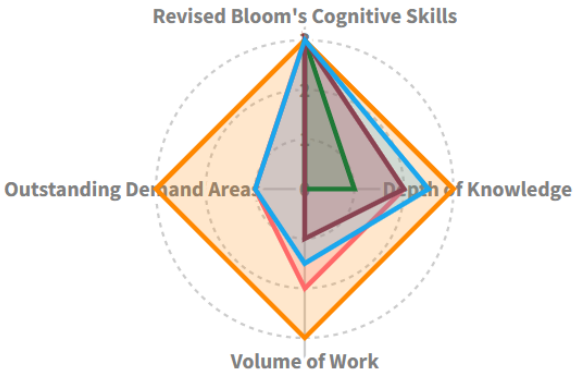
FNCC Advanced (compulsory + optional)



DP AA SL/HL and FNCC



DP AI SL/HL and FNCC



The panel of experts carried out a detailed analysis of each course and reached a consensus on the scores shown in the profiles above. The following points were particularly important within the panel discussion:

- Regarding the scores for **Bloom's Cognitive Skills**:
  - The DP mathematics subject group learning outcomes apply to all subjects hence the scores are the same for AA (SL and HL) and AI (SL and HL). These outcomes were given a score of 3 on the basis that they strongly evidenced the development of critical and creative thinking skills through their focus on reasoning, inquiry-based approaches, reflection, generalisation, unfamiliar contexts, and consideration of wider implications.
  - Similarly, the FNCC learning outcomes are the same for both the basic and advanced syllabus and were given a score of 3. The general objectives, task of the subject, and transversal competencies together had a strong presence of higher order thinking skills through their focus on students' ability to discuss mathematics, substantiate arguments, use investigative actions, solve real-world problems, and evaluate mathematical information.

- Regarding the scores for **Depth of Knowledge**:
  - Both DP mathematics subjects at SL were given a score of 2. Both subjects were judged to cover the topics of 'Number and algebra', 'Functions', 'Geometry and trigonometry', 'Statistics and probability', and 'Calculus' in considerable detail, building in complexity and requiring a substantial amount of pre-requisite knowledge. At HL, both DP mathematics subjects were awarded a score of 3 for depth of knowledge. The subjects were judged to cover topics in a high level of detail, with many sub-topics having high complexity and requiring a large amount of pre-requisite knowledge.
  - For FNCC, the basic syllabus was given a score of 1 for depth. Generally, the coverage of topics was shallow and often focused on basic concepts. Furthermore, the optional studies did not offer a considerable amount of further depth, as they included the binomial and normal distributions and an introduction to calculus. Hence, complexity was limited and was not on par with DP SL, thus a score of 1 was deemed appropriate. For the advanced syllabus, it was logical to consider two scenarios, (i) compulsory modules only and (ii) compulsory and optional modules combined. For the compulsory modules alone, a score of 2 was given due to topics being covered in considerable detail, which was comparable to that of SL. When considering the compulsory and optional modules together, there is some evidence of further depth, as the optional modules extend learning in vectors and statics and probability, however, this was not deemed enough to warrant a 3, and thus a score of 2.5 was given.

- Regarding the scores for **Volume of Work**:
  - Both DP mathematics subjects at SL were deemed to comprise of a moderate-heavy volume of work and were given a score of 2. The panel concluded that the teaching time allotted to cover the different concepts was short (150 hours) but acknowledged that some sub-topics contained basic concepts and recapped prior learning, hence 2 was deemed an appropriate score. For HL, both DP mathematics

subjects were considered to have a heavy volume of work, due to the short amount of time allocated (240 hours) and the level of complexity of the content, which combined merited a score of 3.

- For the FNCC, each credit has 14.25 hours of teaching hours allocated. The total teaching time for the basic syllabus (for all modules) is 228 hours, which was deemed a generous amount of time to cover the amount of topics in the syllabus, thus it received a score of 0. For the advanced syllabus, two scenarios were considered again. For the compulsory modules only, a teaching time of 285 hours was deemed a standard amount of time for the breadth and depth of the content described, thus was given a score of 1. For compulsory and optional modules combined, panellists decided that the allocated time of approximately 28 hours for each optional module was slightly more demanding, given the increase in complexity of these modules. To acknowledge this, whilst also considering that most modules had a standard amount of time allocated, a score of 1.5 was deemed appropriate for the combination of compulsory and optional modules.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - Both DP mathematics subjects at SL and contained one area of demand, which was the 'mathematical exploration'. This element of the SL subjects was considered to apply skills typically needed in higher education, such as extended writing and presentation of mathematical concepts, student-led exploration, and academic writing skills. Therefore, a score of 1 was awarded to both SL subjects for the inclusion of this element. In addition to this, both subjects at HL had further areas of outstanding demand. For mathematics: analysis and approaches, some of the identified outstanding areas of demand were proof by induction, complex numbers (De Moivre's theorem), vectors (cross product, equations of planes and intersections), continuous random variables (probability density functions), and Maclaurin series. For mathematics: applications and interpretation, some identified areas of outstanding demand were eigenvalues and eigenvectors, nonlinear regression, Markov chains, second order differential equations, slope fields, Euler's method, and phase portraits. Overall, there was a high number of outstanding areas of demand and a score of 3 was awarded to both HL subjects.
  - For FNCC, no outstanding areas were found in the basic syllabus, which covered content that was typical of upper secondary mathematics, thus was awarded a score of 0 for this category. For the advanced syllabus, the compulsory modules alone did not contain any areas of outstanding demand, thus were given a score of 0. When considering the optional modules combined with the compulsory modules, some areas of outstanding demand emerged in the module of 3D geometry, and thus a score of 1 was deemed appropriate.

5.2 Physics

Below is the list of subjects used in the physics subject comparison analysis of the DP with the FNCC.

DP physics[115]
Physics is a subject option from the DP sciences subject group, offered at both SL and HL. This subject has content that is common to both SL and HL, as well as AHL content that is featured only at HL. Thus, HL has greater breadth and depth than SL. This subject is intended to prepare students for university courses such as engineering, physics, and others requiring a strong science background. HL is suitable for those intending to pursue further study in an area requiring a strong background in physics

FNCC physics[116]
The Finnish National Agency for Education provides a framework, upon which local education establishments put together their curriculum. Each science discipline is composed of 'compulsory' and 'optional' studies (or modules). Students are required to study all compulsory studies, but they have choice over which, if any, optional studies they take. Through the physics curriculum, students learn to understand the significance of physics for daily life, the environment, society and technology. Physics provides students with the skills to succeed in further studies in natural sciences as well as the world of work. The teaching and learning of physics are based on observations made about the environment. As their studies progress, students learn research skills through experimentation and become able to critically evaluate everyday choices and viewpoints in social debates.

5.2.1 Learning Outcomes – Physics

This section compares and contrasts the learning outcomes of curricula falling within the category of physics.

The learning outcome themes for physics were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for physics, chemistry and biology. The FNCC outlines a 'task of the subject' section which provides overarching ideas about the intended development of students' knowledge and understanding in each subject. Additionally, the FNCC includes a section on 'general objectives of instruction of physics' which is further broken down into three sub-sections: 'meaning, value and attitudes', 'research skills' and 'knowledge of physics and its use', each of which has its own objectives. An 'Assessment Framework' section is also included, providing general information regarding what skills students should be assessed on. Finally, the FNCC also includes a section on 'transversal competencies' which describes how the philosophical underpinnings of the FNCC are integrated within the instruction of physics as a subject – including societal competence, interaction competence, ethical and environmental competence, global and cultural competence, multidisciplinary and creative competence, as well as well-being. Notably, the FNCC as a whole has a holistic approach and puts particular emphasis on the

[115] International Baccalaureate. (2023). *Physics guide*.
[116] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.*

integration of wider skills into their physics curriculum, and a lesser focus on subject-specific scientific knowledge.

The following table demonstrates the learning outcome themes that were extracted from the DP learning outcomes and indicates if and where they were judged to have presence within the learning outcomes of the FNCC physics curricula.

Table 19: Presence of the DP sciences subject group learning outcome themes in the FNCC physics curricula

Themes extracted from learning outcomes of the DP sciences subject group	Presence in FNCC	
1. Conceptual understanding and making connections		Present in all areas. The FNCC describes the application of physics competence to the world of work and organising notions about natural phenomena with the help of concepts in physics.
2. Use and application of knowledge, methods, tools, and techniques that characterize science		Present in general objectives from the description of producing knowledge by scientific methods.
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present in all areas. The FNCC describes student developing research skills, interpreting, analysing and critically evaluating information.
4. Skills for scientific inquiry		Present in general objectives; formulating questions about observed phenomena, developing starting points for research and problem-solving are all clearly described.
5. Development of technological skills		Present in transversal competencies and aims through the use of information and communication technology to collect observations, interpret measurements and present work
6. Effective collaboration and communication		Present. Project learning, group work, joint decision-making, collaborative skills and participation in social debates are all present in the FNCC transversal competencies and aims.
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. This is a strong theme in the FNCC as it repeatedly mentions the importance of physics both in everyday life, building a sustainable future and using competence in physics to take responsibility for environmental action.

Key:

	This theme is well-evidenced in the learning outcomes of the FNCC		*This theme is partially evidenced in the learning outcomes of the FNCC*		*This theme is not evident in the learning outcomes of the FNCC*

Presence of the DP's Learning Outcome Themes

As can be seen in the table above, all learning outcome themes extracted from the DP are present in one or more areas of the FNCC. Conceptual understanding is evident from the emphasis placed by the general objectives on organising notions about structure and phenomena with the help of concepts and principles of physics. Making inter-disciplinary connections, on the other hand, is implied in statements such as 'succeed in their further studies in natural sciences and other fields that apply' and 'gain sufficient knowledge for further studies in natural sciences and fields that use physics'. Notably, there is less emphasis on making connections within the subject, as the FNCC learning outcomes focus more on linkages between physics and areas outside of the subject itself (i.e. other sciences, and society at large).

The use and application of methods, tools and techniques that characterise science is evident in one of the general objectives, which requires students to 'understand the characteristics and development of knowledge of natural sciences as well as the scientific methods for producing knowledge'. It is also mentioned under the 'Meaning, values and attitudes' sub-section, which requires students to 'apply learning strategies in physics', and in the 'Research skills' sub-section, which alludes to students being able to 'carry out experimental research in collaboration with others'.

Creativity and critical thinking are referenced throughout all strands of the FNCC physics, being reflected in statements such as: 'develop their overall research skills', 'face their learning challenges and apply learning strategies', and 'process, interpret, and present research results and evaluate them and the entire research process'. There is further evidence from the general objectives stating that students should formulate questions about the phenomena being observed and use these questions for research and problem-solving.

Mentioning of scientific inquiry is also present, with FNCC's objectives stating that students should be 'able to plan and carry out experimental research', use 'appropriate programs as tools for […] expressing numerical and graphical solutions and results' and 'able to formulate questions about the phenomena being observed and develop the questions further into starting points for research, problem-solving or other activity'.

Technological skills are referred to and expanded upon in the transversal competences, with mention of information and communication technology being used for 'searching for information, collecting experimental observations, processing and interpreting measurement results, composing and presenting work'. This suggests the FNCC places significant importance on students feeling confident with their skills in the use of technology.

Communication and collaboration are also mentioned in the transversal competences and throughout the general objectives. Statements such as 'joint decision-making…interaction and perseverance…participating in debates…research in collaboration with others…express conclusions and viewpoints in ways characteristic of physics' reflect that this is a skill highly valued in the FNCC.

Finally, throughout all areas of the FNCC physics there is emphasis on awareness of local and global problems and the impact of science. Statements such as '…the importance of physics in building a sustainable future…physics is needed in developing new

solutions…taking responsibility for the environment…evaluate the significance of physics for society…decision-making about the environment and technology' exemplify how cross cutting this theme is throughout FNCC physics.

Other Themes in the FNCC

The FNCC emphasises the importance of collaboration with outside agencies to give students a more real-world experience of physics: 'have the opportunity to become familiar with applications of physics through visits or collaboration with higher education institutions or workplaces at a local or international level' – something that is not as explicitly mentioned in the DP.

Other than this, there are no prominent learning outcome themes in the FNCC physics that are not present or related to the DP themes. The Finnish curriculum provides more detail on potential considerations around the ethical, environmental and societal implications of technology and scientific investigation, as well as the importance of physics in developing a sustainable future, ensuring human and environmental welfare locally, nationally and globally. While these themes are mentioned in the DP, the latter is less specific as to the approach to covering them, allowing greater flexibility.

Summary

All learning outcome themes extracted from the DP are present to some extent in FNCC physics. The latter features several references to collaborative working and communication, as well as an awareness of the 'bigger picture' which aligns closely with the DP's view that physics 'encompasses everything we do as human beings'[117] and advances 'communication, medical technology and renewable energy'.[118]

The FNCC also takes a very skills-focused approach, emphasising conceptual understanding and linking physics to the outside world, but the idea of making connections within the subject is less apparent as the FNCC places more emphasis on linkages between physics and areas outside of the subject itself (i.e. other sciences, and society at large).

The FNCC features fewer references to investigative techniques than the DP. These are referred to quite generally and are implicit within statements relating to 'recognising impacts of error' and 'developing research skills'.

Overall, however, the FNCC physics aims to enable students to be able to contribute fully to society and have an appreciation of the importance of physics in many aspects of life – a very similar overall aim to that of the DP physics course.

5.2.2 Content – Physics

This section compares and contrasts the content of the DP and FNCC curricula falling within the category of physics. In order to support visual comparison at-a-glance, the DP and FNCC physics curricula are presented below in diagrams which show the key topics and sub-topics (where available) included in each.

[117] International Baccalaureate. (2023). *Physics guide*. p9.
[118] Ibid.

Figure 15: DP physics content visualiser[119]

A. Space, time and motion	A.1 Kinematics	A.2 Forces and momentum	A.3 Work, energy and power	A.4 Rigid body mechanics (HL only)	A.5 Galilean and special relativity (HL only)
B. The particulate nature of matter	B.1 Thermal energy transfers	B.2 Greenhouse effect	B.3 Gas laws	B.4 Thermodynamics (HL only)	B.5 Current and circuits
C. Wave behaviour	C.1 Simple harmonic motion (SL + AHL)	C.2 Wave model	C.3 Wave phenomena (SL + AHL)	C.4 Standing waves and resonance	C.5 Doppler effect (SL + AHL)
D. Fields	D.1 Gravitational fields	D.2 Electric and magnetic fields	D.3 Motion in electromagnetic fields	D.4 Induction (HL only)	
E. Nuclear and quantum physics	E.1 Structure of the atom (SL + AHL)	E.2 Quantum physics (HL only)	E.3 Radioactive decay (SL + AHL)	E.4 Fission	E.5 Fusion and stars
Experimental programme	Practical work	Collaborative sciences project	Scientific investigation		

[119] '(HL only)' and '(SL + AHL)' are used to flag, respectively, topics only taught at HL and topics taught at both SL and HL, but which also feature additional higher level content.

Figure 16: FNCC physics content visualiser

Compulsory	FY1 Physics as a natural science (1 credit)	FY2 Physics, the environment and society (1 credit)				
Optional	FY3 Energy and heat (2 credits)	FY4 Force and motion (2 credits)	FY5 Periodic motion and waves (2 credits)	FY6 Electricity (2 credits)	FY7 Electromagnetism and light (2 credits)	FY8 Matter, radiation, and quantisation (2 credits)

Structure

The Finnish physics curriculum is constructed using the National Core Curriculum for GUSE as guidance, though the document provides substantial leeway for schools to create their own syllabus.[120] In fact, all education providers prepare a local curriculum based on the FNCC, with each drawing up a plan to organise the national core curriculum into the school year,[121] which impacts the amount of time and emphasis placed on subject content. Notably, the local curriculum is prepared in a way that allows students to make their own decisions about the subjects they focus on.

The DP and FNCC physics have very different structures. The content in DP physics is organised into five over-arching topics (A-E), each with various key areas within them. FNCC physics consists of 'compulsory studies' and 'national optional studies' which are worth different numbers of credits towards the final 150 the student needs to earn. All students must complete the physics compulsory studies, but can choose which, if any, of the national optional studies to complete. For FNCC physics, there are two compulsory study units: FY1 and FY2, worth one credit each. The national optional studies (FY3, FY4, FY5, FY6, FY7 and FY8) are worth two credits each. Each of the compulsory and national optional studies contain a bullet point list of 'core contents' and some general guidance on how the content could be investigated. However, as discussed above, the precise delivery of the content is decided by the education provider.

Content Alignment

The figure below shows a simplified summary of the extent to which FNCC physics aligns with the main topics of DP physics (SL and AHL).

Figure 17: Summary of the content alignment between the DP physics topics and FNCC physics

DP physics subtopics	SL presence in FNCC	AHL presence in FNCC
A. Space, time and motion		
A.1 Kinematics		N/A
A.2 Forces and momentum		N/A
A.3 Work, energy and power		N/A
A.4 Rigid body mechanics	N/A	
A.5 Galilean and special relativity	N/A	
B. The particulate nature of matter		
B.1 Thermal energy transfers		N/A
B.2 Greenhouse effect		N/A
B.3 Gas laws		N/A
B.4 Thermodynamics	N/A	
B.5 Current and circuits		N/A
C. Wave behaviour		
C.1 Simple harmonic motion		
C.2 Wave model		N/A
C.3 Wave phenomena		
C.4 Standing waves and resonance		N/A
C.5 Doppler effect		
D. Fields		
D.1 Gravitational fields		
D.2 Electric and magnetic fields		

[120] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.13.
[121] Ibid.

D.3 Motion in electromagnetic fields		N/A
D.4 Induction	N/A	
E. Nuclear and quantum physics		
E.1 Structure of the atom		
E.2 Quantum physics	N/A	
E.3 Radioactive decay		
E.4 Fission		N/A
E.5 Fusion and stars		N/A
Experimental programme		

Key:

	Strong presence of this topic in the FNCC.		*Partial presence of this topic in the FNCC.*		*Little or no presence of this topic in the FNCC.*	N/A	*This topic does not exist at the respective level.*

As seen in the figure above**,** the broad topic coverage in FNCC is somewhat similar to the DP physics, but with substantial gaps in the coverage of certain topics. At SL, most sub-topics are covered to some extent, but there are considerable gaps in topic C. Wave behaviour as there is no alignment with C.3 Wave phenomena, C.4 Standing waves and resonance, and C.5 Doppler effect. Moreover, the depth to which topics are studied appears to be significantly more limited than the coverage they are offered in the DP – though the exact depth is not possible to ascertain from the documentation, as each education provider prepares their own local curriculum based on the FNCC.

When it comes to alignment with HL, FNCC is missing some AHL content from all topic areas of the DP, particularly in topics D. Fields and E. Nuclear and quantum physics, which are fully absent. There is some level of alignment with some of the content within the other topics, such as B.4 Thermodynamics, C.1 Simple harmonic motion, and C.3 Wave phenomena, though the exact depth and breadth of coverage is unclear from the documentation. The DP's experimental programme is partially aligned with FNCC physics. Within the FNCC 'task of the subject' for physics,[122] there is reference to 'experimentation in its different forms' in order for students to 'learn research skills…as well as skills related to the core contents of the module'. The FNCC includes, at the end of each module, a list of suggested practical experiments that students can undertake. However, there is no description of the extent to which data is analysed or whether any form of write-up is completed. This follows the style of the FNCC documentation, which provides guidance on which the local education establishments then build their own curricula, and allowing freedom of choice regarding the amount and type of practical work to be conducted.

As can be seen below, there are also a few topics which are covered by FNCC physics but are absent from DP physics. However, the style of the FNCC makes it difficult to deduce how large these topics are, or how much detail they go into. 'Proportions of the universe', for example, could make up a very small part of the 'FY1 Physics as a natural science' module, or it could be a considerable topic. Electrical safety and the electromagnetic spectrum, in turn, seem to be covered to what appears to be to a level similar to lower-secondary education in some contexts.

*Table 20: FNCC physics content which is not covered in the DP**

[122] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.301

Significant FNCC content which is not included in DP physics*
• The proportions of the universe • The structure of matter – likely to be covered in lower-secondary education prior to the DP • Modelling different concepts (planetary motion) • Components of electrical circuits (diodes, semiconductors) • Electrical safety (fuses, protection rating) – likely to be covered in lower-secondary education prior to the DP • Electromagnetic spectrum – likely to be covered in lower-secondary education prior to the DP • Biological effects of ionising radiation and its application in medicine and technology

*Significant content does not include topics that are typically studied *prior* to upper secondary

Summary

While there are similarities between the topic coverage of the FNCC and the DP, there is less alignment with regard to depth, as many of the sub-topics within the DP curriculum are absent from the FNCC. This is particularly the case for sub-topics within the DP's C. Wave behaviour topic, which are almost entirely absent from the KHSCG physics syllabus.

However, these limitations in depth may be partially due to the FNCC's less prescriptive nature in regard to subject content. Notably, given that each education provider develops their own curriculum based on the FNCC, the fact that these sub-topics are not explicitly mentioned in the latter does not necessarily mean that they are altogether absent from the former.

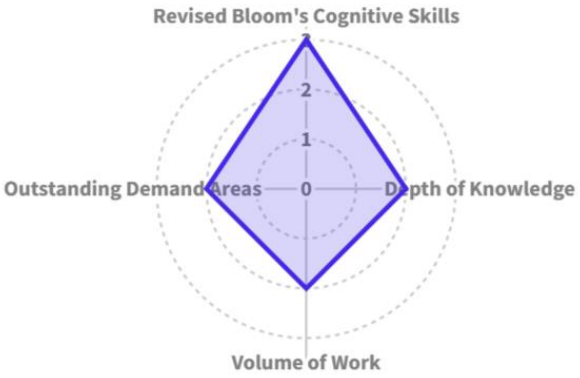
5.2.3 Demand – Physics

The DP curriculum and FNCC were analysed using the same demand tool in order to create a demand profile for DP physics SL, DP physics HL, FNCC physics (compulsory)[123], and FNCC physics (compulsory and optional)[124]. These demand profiles are presented below in the form of radar diagrams, including diagrams showing multiple profiles superimposed in one place, enabling immediate visual comparison.

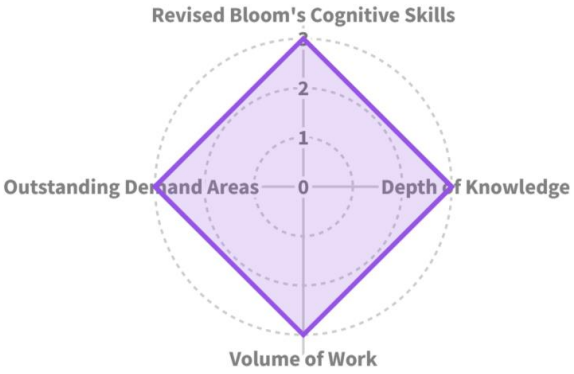
[123] This profile includes only the compulsory modules of the FNCC physics syllabus.
[124] This profile includes all the modules in the FNCC physics syllabus, both compulsory and optional.

Figure 18: Visual representations of subject demand

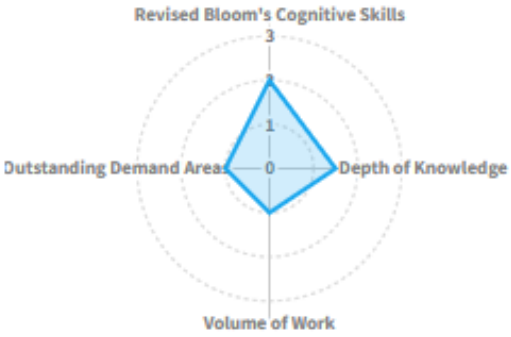
DP physics SL



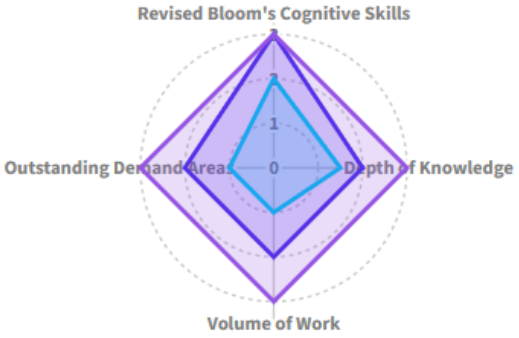
DP physics HL



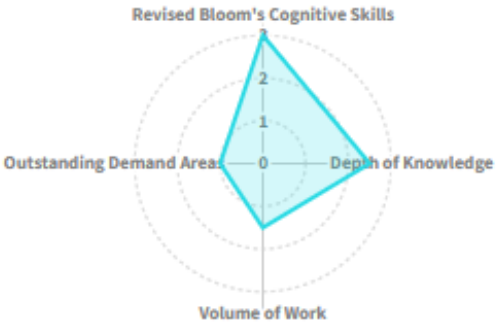
FNCC physics (compulsory)



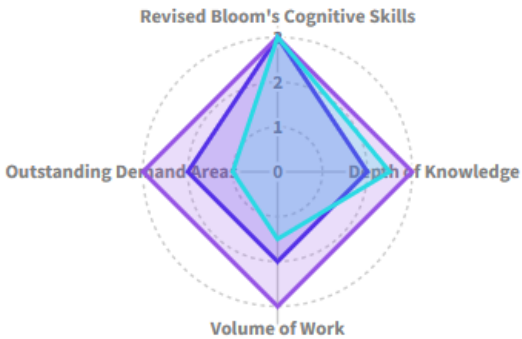
DP and FNCC compulsory physics



FNCC physics (compulsory + optional)



DP and FNCC compulsory + optional physics



The panel of experts carried out a detailed analysis of each course and reached a consensus on the scores shown in the profiles above. The following points were particularly important within the panel discussion:

- Regarding the scores for **Bloom's Cognitive Skills**:
  - DP physics has the same learning outcomes for both SL and HL, meaning that these scores are the same. These were judged to merit a score of 3 due to the high levels of critical thinking, critical awareness and elements of synthesis and creation present in the majority of aims and Assessment Objective 3.
  - Finland's compulsory physics was given a score of 2 for Bloom's due to the substantial focus of the subject's learning outcomes on application and analysis. Although references to higher order thinking skills such as evaluation, creation and problem solving are present, the opportunity to develop them within the limited time available for studying the compulsory modules impeded the award of a score of 3. For Finland's compulsory and optional physics combined, the score of 3 was given, as there is greater emphasis on, and opportunity for development of, higher order thinking skills, independence and research skills within the students' learning.

- Regarding the score for **Depth of Knowledge**:
  - DP physics SL was deemed to merit a score of 2 for depth of knowledge due to the mathematical pre-requisite skills and competences required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - The score of 1.5 was agreed upon for compulsory physics. This was reached due to the presence of research skills, such as 'formulate questions' and 'carry out experimental research', as well as a considerable amount of problem solving within the curriculum. However, due to the FNCC being so open and adaptable to the students' learning, the lack of detail on the depth of knowledge prevents this judgement from being increased further based on compulsory physics alone. For compulsory and optional studies in FNCC physics, the score of 2.5 was awarded. Given the advanced research skills targeted in the curriculum, if students study both the compulsory courses and some the optional courses, their experience of the subject is likely to include considerable strategic and extended thinking.

- Regarding the scores for **Volume of Work**:
  - DP physics SL was judged to comprise a moderate-heavy workload (a score of 2) as students are exposed to multiple physics topics, with each topic being allocated a standard to short amount of time. The volume demands of the HL course, on the other hand, were found to be sufficient to meet a score of 3 as, even though the proportion of topics studied in the same amount of time is smaller, these topics are covered in great depth and with a focus on application.
  - The FNCC compulsory physics was given a score of 1. The amount of time devoted to the compulsory modules is generous and therefore a score of 1 was deemed appropriate, though an important factor is that school-level flexibility in the curriculum does make an accurate judgement challenging. For FNCC physics' compulsory and optional studies combined, a score of 1.5 was given based on the increased complexity of the content covered in some of the

optional courses, and the moderate number of themes covered in the allocated time.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - For the DP physics SL course (awarded a score of 2), the IA scientific investigation research project that students need to undertake, the linking questions outlined in the syllabus and the collaborative sciences project were considered to be areas of stretch. In addition to the latter, the HL course features additional higher levels topics which were deemed to include additional areas of stretch, meriting a score of 3.
  - The emphasis that the FNCC compulsory physics curriculum places on skills and research results in a judgement of 1. These areas can be extended, and tailored delivery of the curriculum would allow for students to be stretched. As to FNCC compulsory and optional physics, two stretch areas were found in the optional content: astrophysics and quantum physics. These, coupled with the emphasis that the FNCC places on skills and research, were seen to amount to two stretch areas in total, giving compulsory and optional physics combined a judgement of 2 for outstanding areas of subject demand.

5.3 Chemistry

Below is the list of subjects used in the chemistry subject comparison analysis.

DP chemistry[125]
Chemistry is a subject option offered within the DP sciences subject group, at both SL and HL. This subject has content that is common to both SL and HL, as well as AHL content that is featured only in the HL. Thus, the HL has greater breadth and depth than SL. This subject is designed to prepare students for university courses such as medicine, biological science and environmental science. HL is suitable for those intending to pursue further study in an area requiring a strong background in chemistry.

FNCC chemistry[126]
The Finnish National Agency for Education provides a framework on which local education establishments put together their curriculum. Each science discipline is composed of 'compulsory' and 'optional' studies (or modules). Students are required to study all compulsory studies, but they have free choice over which, if any, optional studies they take. Through the chemistry curriculum, students learn to understand the significance of chemistry for everyday life and society, and for solving environmental challenges. The curriculum develops students' curiosity about the study of chemistry and provides them with skills needed to succeed in further studies. Chemistry supports the understanding of concepts and phenomena in such a way that integrates their macroscopic, microscopic and symbolic levels. Observation and examination are key components in the teaching and learning of chemistry, and experimental work supports understanding and research skills.

5.3.1 Learning Outcomes – Chemistry

This section compares and contrasts the learning outcomes of curricula falling within the category of chemistry.

The learning outcome themes for chemistry were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for chemistry, physics and biology. The FNCC outlines a 'task of the subject' section which provides overarching ideas about the intended development of students' knowledge and understanding in each subject. Additionally, the FNCC includes a section on 'general objectives of Instruction of chemistry' which is further broken down into three sub-sections: 'meaning, value and attitudes', 'research skills' and 'knowledge of chemistry and its use', each of which has its own objectives. An 'Assessment Framework' section is also included, providing general information regarding what skills students should be assessed on. Finally, the FNCC also includes a section on 'transversal competencies' which describes how the philosophical underpinnings of the FNCC are integrated within the instruction of chemistry as a subject – including societal competence, interaction competence, ethical and environmental competence, global and cultural competence, multidisciplinary and creative competence, as well as well-being. Notably, the FNCC as a whole has a holistic approach and puts particular emphasis on the

[125] International Baccalaureate. (2023). *Chemistry guide*.
[126] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.*

integration of wider skills into their chemistry curriculum, and a lesser focus on subject content and subject-specific scientific knowledge.

The following table demonstrates the learning outcome themes that were extracted from the DP learning outcomes and indicates if and where they were judged to have presence within the learning outcomes of the FNCC chemistry curricula.

Table 21: Presence of the DP sciences subject group learning outcome themes in the FNCC chemistry curricula

Themes extracted from the learning outcomes of the DP sciences subject group	Presence in FNCC	
1. Conceptual understanding and making connections		Present in all areas. FNCC describes how macroscopic, microscopic and symbolic understanding integrate themselves into a logical whole. The importance of chemistry in daily life, modern society, technology and the world of work is also highlighted.
2. Use and application of knowledge, methods, tools, and techniques that characterize science		Present. The reference to students deepening their way of thinking that is typical for the natural sciences and understanding the character of natural sciences evidences the presence of this theme.
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present in all areas through the description of students formulating research questions, critically evaluating information and presenting arguments.
4. Skills for scientific inquiry		Present in task of the subject and general objectives. The FNCC puts the onus on the student to plan their own research and develop their own practical skills. They also utilise appropriate programs for expressing graphical solutions and results.
5. Development of technological skills		Present. In the transversal competencies, the mention of using information and communication technology to search for information, collect observations, process and interpret measurements shows the presence of this them.
6. Effective collaboration and communication		Present. The task of the subject and transversal competencies describe collaboration skills, project learning and group work, as well as joint decision-making and participating in social debates.
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. This is a strong theme of the FNCC, with emphasis on students developing a scientific worldview and understanding how chemistry is required for developing new solutions and ensuring human well-being locally, nationally and globally.

Key:

	This theme is well-evidenced in the learning outcomes of the FNCC.		*This theme is partially evidenced in the learning outcomes of the FNCC.*		*This theme is not evident in the learning outcomes of the FNCC.*

Presence of the DP's Learning Outcome Themes

As can be seen in the table above, all learning outcome themes extracted from the DP are present in one or more areas of the FNCC. Conceptual understanding is evident from the

emphasis placed by the general objectives on providing students with the skills needed to 'use and employ key concepts in chemistry' and 'know how to use different models to describe and explain phenomenon and make forecasts'. Making inter-disciplinary connections, on the other hand, is implied in statements such as 'succeed in their further studies in natural sciences and other fields that apply' and 'obtain sufficient knowledge for further studies in natural sciences and fields that apply chemistry'. Notably, there is a more tenuous emphasis on making connections within the subject, as the FNCC appears to focus more on linkages between chemistry and areas outside of the subject itself (i.e. other sciences, and society at large).

The use and application of methods, tools and techniques that characterise science is evident in one of the general objectives, which requires students to 'understand the properties and development of knowledge of natural sciences and the scientific methods for producing knowledge collaboratively'. It is also mentioned under the 'Meaning, values and attitudes' sub-section, which refers to 'applying learning strategies in chemistry', and in the 'research skills' sub-section, which alludes to students being able to 'carry out experimental research using working methods typical of chemistry'.

Creativity and critical thinking are referenced throughout all strands of the FNCC chemistry learning outcomes, being reflected in statements such as: 'develop their overall research skills', 'meeting learning challenges, and applying learning strategies in chemistry', and 'process, interpret, and present research results and evaluate them and the whole research process'. There is further evidence from the general objectives, stating that students should formulate questions about the phenomena being observed and use these questions for research and problem-solving.

Mention of scientific inquiry is also present, with FNCC's objectives stating that students should 'develop their skills in experimental work towards the planning of their own research', and 'are able to carry out experimental research using working methods typical of chemistry'. Students should also be able to use computer programs to 'express numerical and graphical solutions and results'.

In addition to using computer programs to express solutions and results, technology is mentioned within the transversal competences as a tool to aid the search for information and to make observations, compose and present work, and model. The FNCC also states that 'computer-aided memory systems can [be used for] saving research data as images and videos'.

Communication and collaboration are also mentioned in the transversal competences and throughout the general objectives. Statements such as 'presenting information…develop their collaboration skills…working in groups…social debate and joint decision-making' demonstrate that this is a skill highly valued in the FNCC.

Finally, throughout all areas of the FNCC chemistry there is emphasis on awareness of local and global problems and the impact of science. Statements such as: based on 'the significance of chemistry for society and for solving environmental challenges [and] making social changes…chemistry is required for ensuring environmental well-being' exemplify how cross-cutting this theme is throughout the FNCC chemistry curriculum.

Other Themes in the FNCC

The FNCC emphasises the importance of collaboration with outside agencies to give students a more real-world experience of chemistry: 'have opportunities to become familiar with the applications of chemistry through visits or collaboration with higher education institutions or workplaces at a local or international level' – something that is not as explicitly mentioned in the DP.

Another general objective that is not explicitly encompassed within the learning outcomes of the DP relates to safe working. The FNCC states that students should be 'familiar with safe working methods in chemistry' and be able to 'deal in an appropriate manner with any chemical waste that is produced'. This aligns closely with the emphasis Finland places on understanding the place of chemistry within society, as chemical waste is likely to become a global issue.

On a related note, it is worth mentioning that the Finnish learning outcomes generally provides more detail on potential considerations around the ethical, environmental and societal implications of technology and scientific investigation, as well as the importance of chemistry in developing a sustainable future, ensuring human and environmental welfare locally, nationally and globally. While these themes are mentioned in the DP, the learning outcomes of the latter are less specific as to the approach to covering them, allowing greater flexibility.

Summary

All learning outcome themes extracted from the DP are present to some extent in FNCC chemistry. The latter features several references to collaborative working and communication, as well as an awareness of the 'bigger picture' which aligns closely with the DP's view that chemistry 'often have impacts far beyond the boundaries of academic research'.[127]

The FNCC takes a very skills-focused approach, emphasising conceptual understanding and linking chemistry to the outside world, but the idea of making connections within the subject is less apparent, as the FNCC places more emphasis on linkages between chemistry and areas outside of the subject itself (i.e. other sciences, and society at large). The FNCC also features fewer references to investigative techniques than the DP. These are referred to quite generally and are implicit within statements relating to 'use of appropriate programs as tools for modelling and expressing numerical and graphical solutions and results'.

Overall, despite these differences, the FNCC chemistry aims to enable students to be able to contribute fully to society and have an appreciation of the importance of chemistry in many aspects of life – a very similar overall aim to that of the DP chemistry course.

5.3.2 Content – Chemistry

This section compares and contrasts the content of the DP and FNCC curricula falling within the category of chemistry. In order to support visual comparison at-a-glance, the DP and FNCC chemistry curricula are presented below in diagrams which show the key topics and sub-topics (where available) included in each.

[127] International Baccalaureate. (2023). *Chemistry guide*. p. 9.

Figure 19: DP chemistry content visualiser[128]

Structure	**Structure 1. Models of the particulate nature of matter**	Structure 1.1 – Introduction to the particulate nature of matter	Structure 1.2 – The nuclear atom (SL + AHL)	Structure 1.3 – Electron Configurations (SL + AHL)	Structure 1.4 – Counting particles by mass: The mole	Structure 1.5 – Ideal gases
	Structure 2. Models of bonding and structure	Structure 2.1 – The ionic model	Structure 2.2 – The covalent model (SL + AHL)	Structure 2.3 – The metallic model (SL + AHL)	Structure 2.4 – From models to materials (SL + AHL)	
	Structure 3. Classification of matter	Structure 3.1 – The periodic table: Classification of elements (SL + AHL)	Structure 3.2 – Functional groups: Classification of organic Compounds (SL + AHL)			
Reactivity	**Reactivity 1. What drives chemical reactions?**	Reactivity 1.1 – Measuring enthalpy changes	Reactivity 1.2 – Energy cycles in reactions (SL + AHL)	Reactivity 1.3 – Energy from fuels	Reactivity 1.4 – Entropy and spontaneity (HL only)	
	Reactivity 2. How much, how fast and how far?	Reactivity 2.1 – How much? The amount of chemical change	Reactivity 2.2 – How fast? The rate of chemical change (SL + AHL)	Reactivity 2.3 – How far? The extent of chemical change (SL + AHL)		
	Reactivity 3. What are the mechanisms of chemical change?	Reactivity 3.1 – Proton transfer reactions (includes AHL)	Reactivity 3.2 – Electron transfer reactions (SL + AHL)	Reactivity 3.3 – Electron sharing reactions	Reactivity 3.4 – Electron-pair sharing reactions (SL + AHL)	
Experimental programme	Practical work	Collaborative sciences project	Scientific investigation			

[128] '(HL only)' and '(SL + AHL)' are used to flag, respectively, topics only taught at HL and topics taught at both SL and HL, but which also feature additional higher level content.

Figure 20: FNCC chemistry content visualiser

Compulsory	KE1 Chemistry and I (1 credit)	KE2 Chemistry and a sustainable future (1 credit)		
Optional	KE3 Molecules and models (2 credits)	KE4 Chemical reaction (2 credits)	KE5 Chemical energy and the circular economy (2 credits)	KE6 Chemical equilibrium (2 credits)

Structure

The Finnish chemistry curriculum is constructed using the National Core Curriculum for GUSE for guidance, though the document provides substantial leeway for schools to create their own syllabus.[129] In fact, all education providers prepare a local curriculum based on the FNCC, with each drawing up a plan to organise the national core curriculum into the school year,[130] which impacts the amount of time and emphasis placed on subject content. Notably, the local curriculum is prepared in a way that allows students to make their own decisions about the subjects they focus on.

The DP and FNCC chemistry have very different structures. The content in DP chemistry is organised into two over-arching topics (structure and reactivity), each with various key areas within them. The FNCC chemistry consists of 'compulsory studies' and 'national optional studies' which are worth different numbers of credits towards the final 150 the student needs to earn. Students studying chemistry must complete the compulsory studies, but can choose which, if any, of the national optional studies to take. For the FNCC chemistry, there are two compulsory study units: KE1 and KE2, both worth one credit each. The national optional studies (KE3, KE4, KE5 and KE6), in turn, are worth two credits each. Each of the compulsory and national optional studies contains a bullet point list of 'core contents' and some general guidance on how the content could be investigated. However, as discussed above, the precise delivery of the contents is decided by the education provider.

Content Alignment

The figure below represents a simplified summary of the FNCC's content alignment, at topic-level, with DP chemistry (SL and AHL).

Figure 21: Summary of content alignment between the DP chemistry topics and the FNCC chemistry

DP chemistry topics	SL presence in FNCC	AHL presence in FNCC
Structure 1. Models of the particulate nature of matter		
1.1 Introduction to the particulate nature of matter		N/A
1.2 The nuclear atom		
1.3 Electron configurations		
1.4 Counting particles by mass: The mole		N/A
1.5 Ideal gases		N/A
Structure 2. Models of bonding and structure		
2.1 The ionic model		N/A
2.2 The covalent model		
2.3 The metallic model		
2.4 From models to materials		
Structure 3. Classification of matter		
3.1 The periodic table: Classification of elements		
3.2 Functional groups: Classification of organic compounds		
Reactivity 1. What drives chemical reactions?		
1.1 Measuring enthalpy changes		N/A
1.2 Energy cycles in reactions		
1.3 Energy from fuels		N/A
1.4 Entropy and spontaneity	N/A	

[129] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.13.
[130] Ibid.

Reactivity 2. How much, how far and how fast?		
2.1 How much? The amount of chemical change		N/A
2.2 How fast? The rate of chemical change		
2.3 How far? The extent of chemical change		
Reactivity 3. What are the mechanisms of chemical change?		
3.1 Proton transfer reactions		
3.2 Electron transfer reactions		
3.3 Electron sharing reactions		N/A
3.4 Electron-pair reactions		
Experimental programme		

Key:

	Strong presence of this topic in the FNCC.		*Partial presence of this topic in the FNCC.*		*Little or no presence of this topic in the FNCC.*	N/A	*This topic does not exist at the respective level.*

.

The breadth of topics covered by the FNCC is somewhat less than DP chemistry, with substantial gaps in the coverage of certain topics. However, most of the SL topics are covered at least partially and there is strong alignment with the content in Structure 2 – Models of bonding and structure, particularly in the coverage of 2.2 – Covalent model, 2.3 – The metallic model and 2.4 – From models to materials. Nevertheless, there are considerable gaps in the coverage of Reactivity 3, with the FNCC chemistry syllabus including no explicit coverage of 3.1 – Proton transfers, 3.3 – Electron sharing reactions, 3.4 – Electron-pair reactions and only partial coverage of 3.2 – Electron transfer reactions.

When it comes to alignment with DP HL, there is strong coverage of Structure 2.4 – From models to materials, and partial coverage of Structure 1.2 – The nuclear atom; Structure 3.1 – The periodic table: classification of elements; Reactivity 1.2 – Energy cycles in reactions; Reactivity 2.3 – How far? The extent of chemical change; and Reactivity 3.4 – Electron-pair reactions. However, most topics are covered is less depth than the DP. Moreover, some DP AHL content is absent from all areas of FNCC chemistry, particularly that within Structure 2 and Reactivity 3. The DP's experimental programme is partially aligned with the FNCC chemistry curriculum. Within the FNCC task of the subject,[131] there is reference to 'experimentation in its different forms' in order for students to 'learn research skills and the understanding of the character of natural sciences'. This section also states that students will 'plan their own research…evaluate and present arguments about results'. Within the general objectives for chemistry[132] students will become capable of carrying out experimental research and presenting results from this. The FNCC includes, at the end of each module, a list of suggested practical experiments that students can undertake. Although the FNCC emphases the importance of practical work in chemistry, there is not enough detail in the documentation to determine whether this is independent or collaborative work and the extent to which a written report of findings is created. This follows the style of the FNCC documentation, which provides guidance on which the local education establishments then build their curricula, allowing freedom of choice regarding the amount and type of practical work to be carried out.

As can be seen in the table below, there are also a few topics which are covered by FNCC chemistry but are absent from DP chemistry. The style of the FNCC makes it difficult to deduce

[131] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.312
[132] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.314

how large these topics are, or how much detail they go in to. 'Sustainability', for example, could make up a very small part of the curriculum, but the title of the KE2 module (chemistry and a sustainable future) suggests that this is a rather large component. Using chemistry to solve health or environmental problems is a topic that is easily covered at a basic level, but could also be extended into more complex scenarios; however, the detail is not present in the FNCC documentation to ascertain this.

Table 22: FNCC chemistry content which is not covered in the DP

Significant FNCC content which is not included in DP chemistry*
• Sustainability • Using chemistry to solve a health or environmental problem

*Significant content does not include topics that are typically studied *prior* to upper secondary.

Summary

While there are similarities between the topic coverage of the FNCC and the DP, there is less alignment with regard to depth, as many of the sub-topics within the DP curriculum are absent from the FNCC. This is particularly the case for sub-topics within the DP's Reactivity 3. What are the mechanisms of chemical change?, which are almost entirely absent from the KHSCG chemistry syllabus.

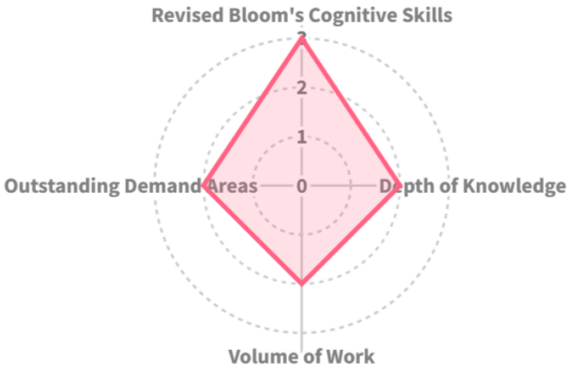
However, these limitations in depth may be partially due to the FNCC's less prescriptive nature in regard to subject content. Notably, given that each education provider develops their own curriculum based on the FNCC, the fact that these sub-topics are not explicitly mentioned in the latter does not necessarily mean that they are altogether absent from the former.

5.3.3 Demand – Chemistry

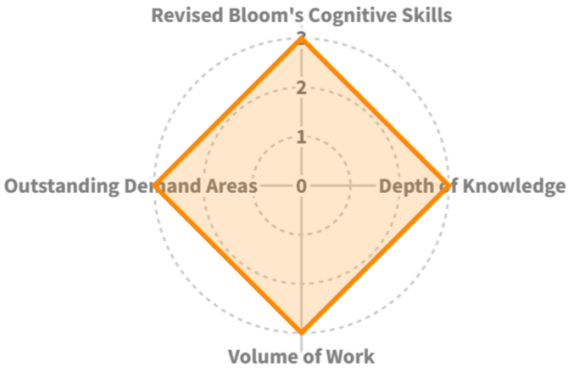
The DP and FNCC curricula were analysed using the same demand tool in order to create a demand profile for DP chemistry SL, DP chemistry HL, FNCC chemistry (compulsory), and FNCC chemistry (compulsory + optional). These demand profiles are presented below in the form of radar diagrams, with the last diagram showing all profiles superimposed in one place, enabling immediate visual comparison.

Figure 22: Visual representations of subject demand

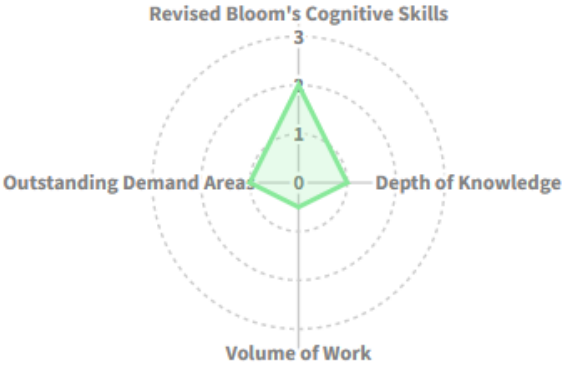
DP chemistry SL



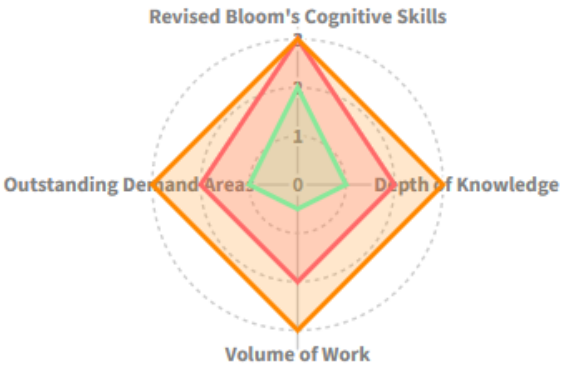
DP chemistry HL



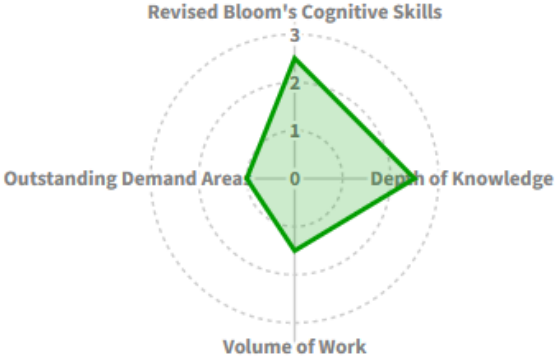
FNCC chemistry (compulsory)



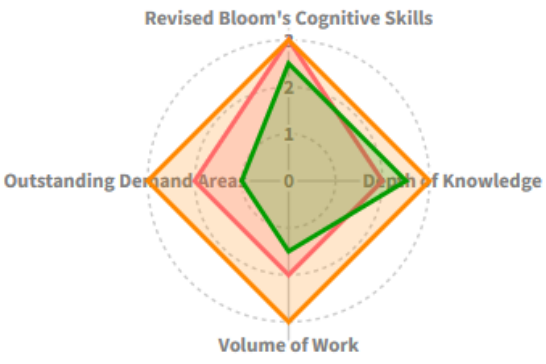
DP and FNCC compulsory chemistry



FNCC chemistry (compulsory + optional)



DP and FNCC compulsory + optional chemistry



The panel of experts carried out a detailed analysis of each course and reached a consensus on the scores shown in the profiles above. The following points were particularly important within the panel discussion:

- Regarding the scores for **Bloom's Cognitive Skills**:
  - DP chemistry has the same learning outcomes for both SL and HL, meaning that these scores are the same. These were judged to merit a score of 3 due to the high levels of critical thinking, critical awareness and elements of synthesis and creation present in the majority of aims and Assessment Objective 3.
  - Finland's compulsory chemistry was given a score of 2 for Bloom's due to the substantial focus of the subject's learning outcomes on application and analysis. Although references to higher order thinking skills such as evaluation, creation and problem solving are present, the opportunity to develop them within the limited time available for studying the compulsory modules impeded the award of a score of 3. For Finland's compulsory and optional chemistry combined, the score of 2.5 was given due to the higher-level thinking skills required for some aspects of practical and research work. However, opportunities for creation and synthesis, though present, were not judged to be the predominant focus, limiting the judgement to a 2.5.

- Regarding the score for **Depth of Knowledge**:
  - DP chemistry SL was deemed to merit a score of 2 for depth of knowledge due to the mathematical pre-requisite skills and competences required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - FNCC compulsory chemistry was judged to be a 1 due to the presence of skills and concepts above those of basic recall and reproduction. The design of the curriculum theoretically allows for a lot of independence from students, but there is limited evidence of how this is put into practice. Content is fairly skeletal in detail and some of it appears to be typical of pre-upper secondary level; it therefore warranted a score of 1. The score of 2.5 was given for compulsory and optional studies for the FNCC chemistry. As students in Finland are very much in control of which courses they study and how many, this affects the depth of knowledge they can obtain in each subject. However, given the advanced research skills targeted in the curriculum, if students study both the compulsory courses and the optional courses, their experience of the subject is likely to include considerable strategic and extended thinking.

- Regarding the scores for **Volume of Work**:
  - DP chemistry SL was judged to comprise a moderate-heavy workload (a score of 2) as students are exposed to various chemistry topics, with each topic being allocated a standard to short amount of time. The volume demands of the HL course, on the other hand, were found to be sufficient to meet a score of 3 – even though the number of topics per hour is smaller, these topics are covered in great depth and with a focus on application.
  - The FNCC compulsory chemistry was given a score of 0.5. The amount of time devoted to the compulsory modules is generous and the content covered in these appears to be of a level expected prior to upper secondary education.

However, since there is evidence that some time is spent on conceptually complex thinking (e.g. there is some emphasis on conceptual understanding and self-directed learning), a score of 0.5 was agreed upon. For FNCC chemistry's compulsory and optional courses combined, a score of 1.5 was given based on the increased complexity of the content covered in some of the optional courses, and the moderate number of themes in total for the respective allocated time.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - For the DP chemistry SL course (awarded a score of 2), the IA scientific investigation research project that students need to undertake, the linking questions outlined in the syllabus and the collaborative science project were seen to be areas of stretch. In addition to the latter, the HL course features additional higher level topics which were deemed to include additional areas of stretch, meriting a score of 3.
  - Both FNCC compulsory chemistry and compulsory and optional chemistry combined were given a score of 1 due to the strong emphasis on research and experimental skills. The latter provide opportunities for students' learning and understanding to be stretched appropriately for their individual strengths, amounting to an area of outstanding subject demand.

5.4 Biology

Below is the list of subjects used in the biology subject comparison analysis.

DP biology[133]
Biology is a subject option within the DP sciences subject group, offered at both SL and HL. This subject has content that is common to both SL and HL, as well as AHL content for HL. Thus, HL has greater breadth and depth than SL. This subject is designed to prepare students for university courses such as biology, medicine, dentistry, and biomedical engineering. HL is suitable for those intending to pursue further study in an area requiring a strong background in biology.

FNCC biology[134]
The Finnish National Agency for Education provides a framework on which local education establishments put together their curriculum. Each science discipline is composed of 'compulsory' and 'optional' studies (or modules). Students are required to study all compulsory studies, but they have free choice over which, if any, optional studies they take. Through the biology curriculum students will develop an interest in life and environmental sciences and understand the structure, function and interrelationships of the natural world. Students will obtain a picture of life sciences as rapidly developing disciplines which have uses in many fields, such as medical science, industry, agriculture and forestry. The teaching and learning of biology are integrated with other subjects, such as geography, chemistry, physics, psychology and health education.

5.4.1 Learning Outcomes – Biology

This section compares and contrasts the learning outcomes of curricula falling within the category of biology.

The learning outcome themes for biology were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for biology chemistry and physics.

The FNCC outlines a 'task of the subject' section which provides overarching ideas about the intended development of students' knowledge and understanding in each subject. Additionally, the FNCC includes a section on 'general objectives of Instruction of biology' which is further broken down into three sub-sections: 'Biological approach, 'Biological phenomena and processes' and 'Biological skills and their application, each of which has its own objectives. An 'Assessment Framework' section is also included, providing general information regarding what skills students should be assessed on. Finally, the FNCC also includes a section on 'Transversal Competencies in the Subject' which describes how the philosophical underpinnings of the FNCC are integrated within the instruction of biology as a subject – including societal competence, interaction competence, ethical and environmental competence, global and cultural competence, multidisciplinary and creative competence, as well as well-being. Notably, the FNCC as a whole has a very holistic approach and puts

[133] International Baccalaureate. (2023). *Biology guide*.
[134] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.*

particular emphasis on the integration of wider skills into their biology curriculum, and a lesser focus on subject content and subject-specific scientific knowledge.

The following table demonstrates the learning outcome themes that were extracted from the DP learning outcomes and indicates if and where they were judged to have presence within the learning outcomes of the FNCC biology curricula.

Table 23: Presence of the DP sciences subject group learning outcome themes in the FNCC biology curricula

Themes extracted from the learning outcomes of the DP sciences subject group	Presence in FNCC	
1. Conceptual understanding and making connections		Present in all areas through the description of biology underpinning understanding of the interrelationships of the natural world and the cross-over of phenomena within biology being examined in other subjects such as geography, chemistry and psychology.
2. Use and application of knowledge, methods, tools, and techniques that characterize science		Present in transversal competences through the description of the ways of knowledge building in biology and the disciplines associated with it, alongside the language and terminology of biology.
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present in transversal competences and general objectives. The FNCC describes students learning to present arguments and evaluate people's views, as well as adopting an enquire-based approach.
4. Skills for scientific inquiry		Present in the task of the subject through reference to information acquired based on observations, experiments, research-based practices and working methods that are both active and interactive.
5. Development of technological skills		Present. As mentioned in the task of the subject, teaching and learning involve laboratory work and work in digital environments.
6. Effective collaboration and communication		Present in transversal competences and general objectives. Students will work in groups to learn to present arguments and develop their social and interaction skills.
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. This theme is strongly emphasis in the FNCC and is therefore present in all areas. There are many references to the importance of biodiversity and how students develop environmental competence as well as finding the initiative to act for positive solutions.

Key:

	This theme is well-evidenced in the learning outcomes of the FNCC.		*This theme is partially evidenced in the learning outcomes of the FNCC.*		*This theme is not evident in the learning outcomes of the FNCC.*

Presence of the DP's Learning Outcome Themes

As can be seen in the table above, all learning outcome themes extracted from the DP are well evidence in the FNCC, apart from one – development of technological skills.

Conceptual understanding is evident from the emphasis placed by the general objectives on knowing 'how to use key concepts in biology accurately and in correct contexts', as well as 'understand biological causal relations', 'command of basic concepts of biology and their

reflection, justification, and research skills', and acquiring 'skills for…further studies'. Making connections is evident from statements such as 'adopt a…multidisciplinary and creative way of working', 'understand the structure, function and interrelationships of the natural world…engage in versatile cooperation with other subjects' and '…knowledge building in biology and the disciplines associated with it'. This is also well-evidenced in the Assessment Framework, which states that assessment should focus on 'understanding of the fundamental principles of natural sciences and causal relations, their grasp of the importance of interrelationships, and their ability to perceive the whole'.

The use and application of methods, tools and techniques that characterise science is also more implied than explicitly stated in the general objectives – 'the ways of knowledge building in biology and the disciplines associated with it'. In the 'task of the subject' section, it is alluded to in statements such as: 'Information acquisition based on observations and experiments, research-based practises, and working methods that are both active and interactive'.

Creativity and critical thinking are referenced throughout all strands of the FNCC biology. The transversal competencies section contains references to both the creative and evaluating aspect of critical thinking – for instance, 'adopt…a multidisciplinary and creative way of working', 'evaluate their and other people's views…adopt an inquiry-based approach', 'analysing information critically' or 'express and justify views in a way that is characteristic for biology'. This is echoed in the general objectives by the mention of using and critically evaluating sources of biological information.

Mentioning of scientific inquiry is also present, though emphasis on research skills is not as prominent as is in FNCC physics and chemistry. The most explicit references to inquiry skills are in statements such as 'evaluate their and other people's views…adopt an inquiry-based approach', 'plan and carry out, independently or in groups, experimental work in various learning environments such as in the field, in laboratories, and in virtual environments'; and 'adopt an inquiry-based approach'.

The 'task of the subject' section contains reference to the development of technology skills through the planning and carrying out of experimental work in 'digital environments'. This, however, is the only reference to technology and does not explicitly state what 'digital environments' actually consist of, or what specific technological skills students should develop.

Effective communication and collaboration skills are well referenced throughout the 'transversal competences' and the 'general objectives' sections. Statements such as 'plan and carry out, independently or in groups, experimental work', 'present arguments…develop student's social and interaction skills', and 'express and justify different views' demonstrate the significant emphasis placed on communication skills in the FNCC biology curriculum.

Finally, throughout all areas of the FNCC biology there is emphasis on awareness of local and global problems and the impact of science. Statements such as 'assuming global responsibility as active members of society', 'applications and ecosystem services in relation to a sustainable future'; 'appreciation of how significant a clean and health environment with rich biodiversity is for the holistic well-being of people' exemplify how cross cutting this theme is throughout the FNCC biology curriculum.

Other Themes in the FNCC

The FNCC general objectives section for biology contains objectives that are very specific to science and much more centred on scientific knowledge. Examples of these are 'know the basic structures and functions of organisms' and 'understand the importance of evolution'. These do not appear in the DP themes as they are very content specific, and their primary purpose relates to acquisition of specific content areas rather than development of skills or techniques.

The FNCC also emphasises the importance of collaboration with outside agencies to give students a more real-world experience of biology: 'familiarise themselves with biological applications through visits or collaboration with higher educational institutions or workplaces at a local or international level' – something that is not as explicitly mentioned in the DP.

Finally, there is also a reference to students having awareness of the research occurring in their own country in relation to biology – 'understand that important research is carried out in Finland'. This is absent from the DP, somewhat expectedly due to the international nature of the programme.

Summary

The FNCC biology contains two different categories of objectives. Some are very broad and aim to interweave many different aspects of a students' learning experience into the teaching of biology, including social, ethical and environmental competences as well as understanding the importance of biology outside the discipline. Then, there are objectives that centre around very specific subject knowledge that appear to be focus on knowledge acquisition rather than development or application of skills, which is different from the layout of aims and objectives in the DP.

This being said, the vast majority of learning outcome themes extracted from the DP are well evidenced in FNCC biology – the exception being the development of technological skills, which is only briefly alluded to. Other than that, FNCC biology features several references to collaborative working and communication, as well as an awareness of the 'bigger picture' which aligns closely with the DP's positioning of the study of biology as key to tackling big issues, such as the 'ever greater pressure on food supplies and on the habitats of other species'.[135]

Overall, thus, the FNCC biology aims to enable students to be able to contribute fully to society and have an appreciation of the importance of biology in many aspects of life – a very similar overall aim to that of the DP biology course.

5.4.2 Content – Biology

This section compares and contrasts the content of the DP and FNCC curricula falling within the category of biology. In order to support visual comparison at-a-glance, the DP and FNCC biology curricula are presented below in diagrams which show the key topics and sub-topics (where available) included in each.

[135] International Baccalaureate. (2023). *Biology guide*. p. 13.

Figure 23: DP biology content visualiser[136]

A: Unity and diversity	**1. Molecules**	A1.1 Water (SL + AHL)	A1.2 Nucleic acids (SL + AHL)	
	2. Cells	A2.1 Origins of cells (HL only)	A2.2 Cell structure (SL + AHL)	A2.3 Viruses (HL only)
	3. Organisms	A3.1 Diversity of Organisms (SL + AHL)	A3.2 Classification and cladistics (HL only)	
	4. Ecosystems	A4.1 Evolution and speciation (SL + AHL)	A4.2 Conservation and biodiversity	
B: Form and function	**1. Molecules**	B1.1 Carbohydrates and lipids	B1.2 Proteins (SL + AHL)	
	2. Cells	B2.1 Membranes and membrane transport (SL + AHL)	B2.2 Organelles and compartmentalization (SL + AHL)	B2.3 Cell specialization (SL + AHL)
	3. Organisms	B3.1 Gas exchange (SL + AHL)	B3.2 Transport (SL + AHL)	B3.3 Muscle and mobility (HL only)
	4. Ecosystems	B4.1 Adaptation to environment	B4.2 Ecological niches	
C: Interaction and independence	**1. Molecules**	C1.1 Enzymes and metabolism (SL + AHL)	C1.2 Cell respiration (SL + AHL)	C1.3 Photosynthesis (SL + AHL)
	2. Cells	C2.1 Chemical signalling (HL only)	C2.2 Neural signalling (SL + AHL)	
	3. Organisms	C3.1 Integration of body systems (SL + AHL)	C3.2 Defence against disease	
	4. Ecosystems	C4.1 Populations and communities	C4.2 Transfers of energy and matter	
D: Continuity and change	**1. Molecules**	D1.1 DNA replication (SL + AHL)	D1.2 Protein synthesis (SL + AHL)	D1.3 Mutations and gene editing (SL + AHL)
	2. Cells	D2.1 Cell and nuclear division (SL + AHL)	D2.2 Gene expression (HL only)	D2.3 Water potential (SL + AHL)
	3. Organisms	D3.1 Reproduction (SL + AHL)	D3.2 Inheritance (SL + AHL)	D3.3 Homeostasis (SL + AHL)
	4. Ecosystems	D4.1 Natural selection (SL + AHL)	D4.2 Sustainability and change (SL + AHL)	D4.3 Climate change (SL + AHL)
Experimental programme	Practical work	Collaborative sciences project	Scientific investigation	

[136] '(HL only)' and '(SL + AHL)' are used to flag, respectively, topics only taught at HL and topics taught at both SL and HL, but which also feature additional higher level content.

Figure 24: FNCC biology content visualiser

Compulsory	BI1 Life and evolution (2 credits)	BI2 Basics of ecology (1 credit)	BI3 Human impact on the ecosystem (1 credit)
Optional	BI4 The cell and heredity (2 credits)	BI5 Human biology (2 credits)	BI6 Biotechnology and its applications (2 credits)

Structure

The Finnish biology curriculum is constructed using the National Core Curriculum for GUSE for guidance, though the document provides substantial leeway for schools to create their own syllabus.[137] In fact, all education providers prepare a local curriculum based on the FNCC, with each drawing up a plan to organise the national core curriculum into the school year,[138] which impacts the amount of time and emphasis placed on subject content. Notably, the local curriculum is prepared in a way that allows students to make their own decisions about the subjects they focus on.

The DP and FNCC biology have very different structures – the DP biology content is organised into four over-arching topics (A-D) each with four key areas (1-4) within them. The FNCC biology consists of 'compulsory studies' and 'national optional studies' which are worth different numbers of credits towards a student's final 150 credits. Students studying biology must complete the compulsory studies, but can choose which, if any, of the national optional studies to complete. For the FNCC biology, there are three compulsory study units: BI1 is worth two credits, BI2 and BI3 are worth one credit each. The national optional studies (BI4, BI5 and BI6) are worth two credits each. Each of the compulsory and national optional studies contain a bullet point list of 'core contents' and some general guidance on how the content could be investigated. However, as discussed above, the precise delivery of the contents is decided by the education provider.

Content Alignment

The figure below represents a simplified summary of the FNCC's content alignment, at topic-level, with DP biology (SL and AHL).

Figure 25: Summary of content alignment between the DP biology topics and FNCC biology

DP biology topics	SL presence in FNCC	AHL presence in FNCC
A. Unity and diversity		
1 Molecules		
2 Cells		
3 Organisms		
4 Ecosystems		
B. Form and function		
1 Molecules		
2 Cells		
3 Organisms		
4 Ecosystems		N/A
C. Interaction and independence		
1 Molecules		
2 Cells		
3 Organisms		
4 Ecosystems		N/A
D. Continuity and change		
1 Molecules		
2 Cells		
3 Organisms		
4 Ecosystems		
Experimental programme		

[137] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.13.
[138] Ibid.

Key:

	Strong presence of this topic in the FNCC.		*Partial presence of this topic in the FNCC.*		*Little or no presence of this topic in the FNCC.*	N/A	*This topic does not exist at the respective level.*

The breadth of topics covered by the FNCC is somewhat similar to the breadth of the DP biology, but with substantial gaps in the coverage of certain topics. When it comes to DP SL content, the FNCC covers all the content in topic A – Unity and Diversity, to a similar depth, apart from the sub-topic of 1. Molecules which is absent. The FNCC also covers the entirety of topics C – Interaction and Independence and D – Continuity and Change, although coverage of these areas is only partial. However, topic B – Form and Function is mostly absent from the FNCC, as the latter does not go into detail of the biochemistry content contained within it; thus, FNCC biology does not (at least explicitly) cover the chemistry of B1.2 Proteins, B2.1 Membrane transport and has very little overlap with B2.2 Organelles and compartmentalisation.

As to AHL content, the FNCC has alignment with some sub-topic areas within each main topic area – i.e. cells and organisms within A – Unity and Diversity and D – Continuity and Change, as well as organisms within B – Form and Function, and molecules and cells within C – Interaction and Independence. However, this alignment is only partial as the depth of coverage of each sub-topic is limited when compared to the DP HL. The DP's experimental programme is partially aligned with the FNCC biology curriculum. Within the FNCC task of the subject,[139] there is reference to characteristic features of biology being 'information acquisition based on observation and experiments, research-based practises', as well as the teaching and learning involving laboratory work. Within the general objectives for biology[140] students will plan and carry out investigations, either independently or in groups, and these could be done in the laboratory or virtually. Unlike physics and chemistry, there are no suggested practical experiments for each module. Although the FNCC emphasises the importance of carrying out practical work in biology, there is a greater focus on the planning and investigation side rather than the data analysis and evaluation aspects. There is also not enough detail in the documentation to determine the extent to which a written report of findings is created following experiments. This follows the style of the FNCC documentation, which provides guidance on which the local education establishments then build their curricula, allowing freedom of choice for the amount and type of practical work to be carried out.

As can be seen below, there are also a few topics which are covered by FNCC biology but are absent from DP biology. The style of the FNCC makes it difficult to ascertain the level of detail to which the topics in the table above are covered. The sustainability aspect and protecting the environment is a factor in the DP; however, the FNCC is specific with regard to the examples and focus of this component, as the curriculum states: 'know methods for examining and following the state of the environment and for identifying environmental problems', 'are able to compare, analyse, and evaluate the impacts of human activity on ecosystems', 'know how to present, with justifications, solutions to environmental problems

[139] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.282
[140] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.284

and recognise positive trends in the state of the environment'[141]. The DP is more general in its approach to this theme, mentioning 'protecting the environment' without the specific emphasis featured in the FNCC.

Table 24: FNCC biology content which is not covered in the DP

Significant FNCC content which is not included in DP biology*
• Secretion of metabolic waste • Utilisation of microbes in technology: gene transfer and modification techniques • Applications of biotechnology and their importance (DNA engineering and examination) • Sustainability and protecting the environment with specific examples and focus

*Significant content does not include topics that are typically studied *prior* to upper secondary

Summary

While there are similarities between the topic coverage of the FNCC and the DP, there is less alignment with regard to depth, as many of the sub-topics within the DP curriculum are absent from the FNCC. This is particularly the case for sub-topics within the DP's B. Form and Function, which are almost entirely absent from the KHSCG biology syllabus.

However, these limitations in depth may be partially due to the FNCC's less prescriptive nature in regard to subject content. Notably, given that each education provider develops their own curriculum based on the FNCC, the fact that these sub-topics are not explicitly mentioned in the latter does not necessarily mean that they are altogether absent from the former.

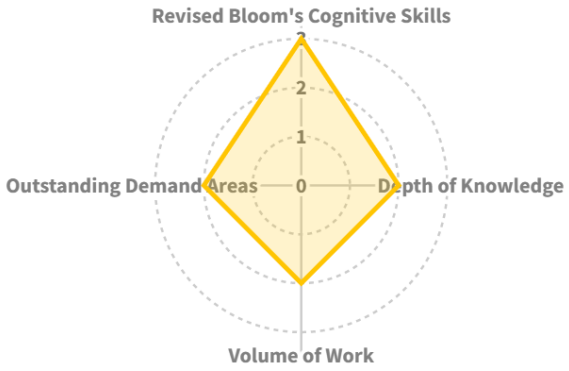
5.4.3 Demand – Biology

The DP and FNCC curricula were analysed using the same demand tool in order to create a demand profile for DP biology SL, DP biology HL, FNCC biology (compulsory), and FNCC biology (compulsory and optional). These demand profiles are presented below in the form of radar diagrams, with the last diagram showing all profiles superimposed in one place, enabling immediate visual comparison.

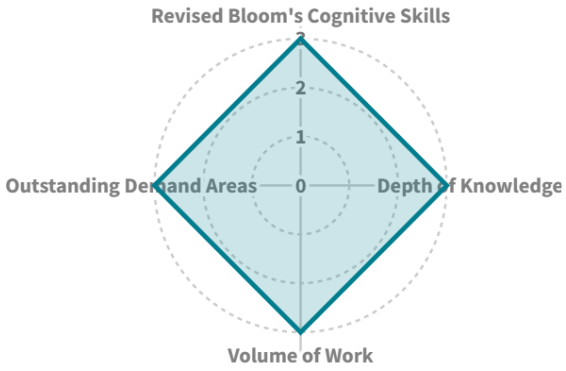
[141] Finnish National Agency for Education. (2019). *NCC for General Upper Secondary Education.* p.288.

Figure 26: Visual representations of subject demand

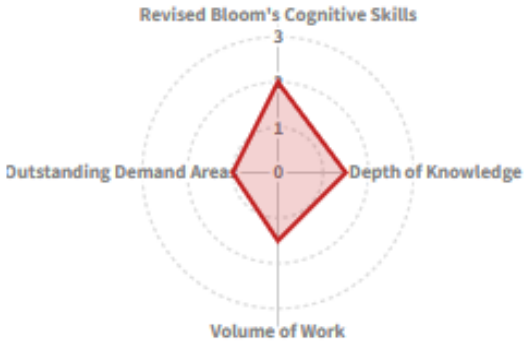
DP biology SL



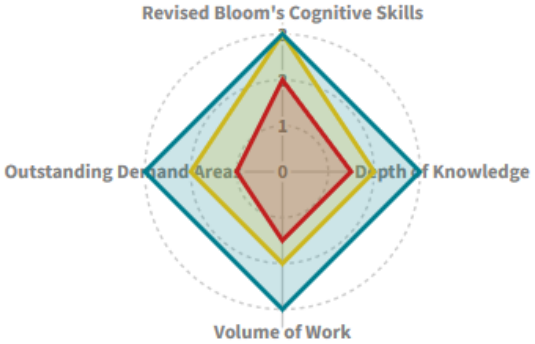
DP biology HL



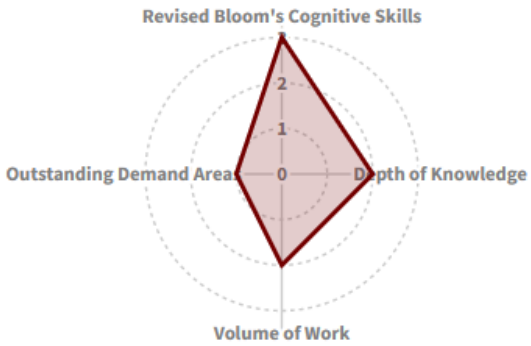
FNCC biology (compulsory)



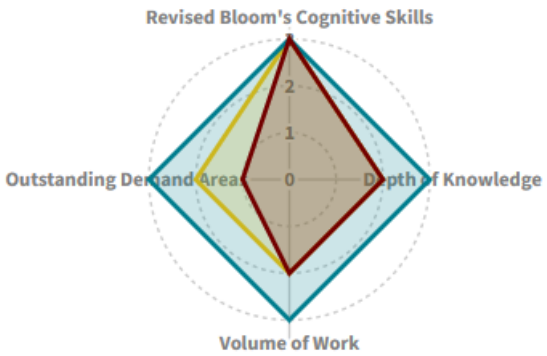
DP and FNCC compulsory biology



FNCC biology (compulsory + optional)



DP and FNCC compulsory + optional biology



The panel of experts carried out a detailed analysis of each course and reached a consensus on the scores shown in the profiles above. The following points were particularly important within the panel discussion:

- Regarding the scores for **Bloom's Cognitive Skills**:
  - DP biology has the same learning outcomes for both SL and HL, meaning that these scores are the same. These were judged to merit a score of 3 due to the high levels of critical thinking, critical awareness and elements of synthesis and creation present in the majority of aims and Assessment Objective 3.
  - Finland's compulsory biology was given a score of 2 for Bloom's due to the substantial focus of the subject's learning outcomes on application and analysis. Although references to higher order thinking skills such as evaluation, creation and problem solving are present, the opportunity to develop them within the limited time available for studying the compulsory modules impeded the award of a score of 3. For Finland's compulsory and optional biology combined, the score of 3 was given as there is greater emphasis on higher order thinking skills and independence within the students' learning.

- Regarding the score for **Depth of Knowledge**:
  - DP biology SL was deemed to merit a score of 2 for depth of knowledge due to the pre-requisite skills and competences (e.g. interpretation of graphs data, mathematics skills, some chemistry and geography links) required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - The score of 1.5 was judged for compulsory biology topics. This was reached due to the presence of research skills such as 'formulate questions' and 'carry out experimental research' as well as a considerable amount of problem solving within the curriculum. However, due to the FNCC being so open and adaptable to students' learning, the lack of detail provided prevents this judgement from being increased, therefore a score of 1.5 was found to be appropriate. For compulsory and optional studies in FNCC biology, the score of 2 was awarded. As students in Finland are very much in control of which courses they study and how many, this affects the depth of knowledge they can obtain in each subject. In biology, however, the depth within the optional modules was limited; for example, students are restricted to focusing on the structure and function of eukaryotic cells, rather than also covering prokaryotic cells. Thus, even if students study both the compulsory courses and some of the optional courses, their experience of the subject will include some higher order thinking but not over extended periods of time, warranting a score of 2.

- Regarding the scores for **Volume of Work**:
  - DP biology SL was judged to comprise a moderate-heavy workload (a score of 2) as students are exposed to multiple biology topics, with each topic being allocated a standard to short amount of time. The volume demands of the HL course, on the other hand, were found to be sufficient to meet a score of 3 – even though the proportion of topics per allocated teaching hour is smaller, these topics are covered in great depth and with a focus on application.
  - The score of 1.5 was given for FNCC compulsory biology due to the moderate number of themes and amount of time on issues beyond basic conceptual

depth. For FNCC compulsory and optional biology courses combined, a score of 2 was given based on the increased breadth of the content covered in some of the optional courses, and the less generous time allocation per topic.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - For the DP biology SL course (awarded a score of 2), the scientific investigation research project that students need to undertake, the linking questions outlined in the syllabus and the collaborative science project were considered to be areas of stretch. In addition to the latter, the HL course features additional higher levels topics which were deemed to include additional areas of stretch, meriting a score of 3.
  - For both FNCC compulsory biology and FNCC compulsory and optional biology combined, a score of 1 was given due to the emphasis on research and experimental skills. The latter provide opportunities for students' learning and understanding to be stretched appropriately for their individual strengths, amounting to an area of stretch.

6. Key Findings

This section summarises the alignment and main similarities and differences found between the DP and Finland's upper-secondary programme, both at programme level and subject level.

6.1 Programme Level

Philosophical Underpinnings

All the key themes within the IB's learner profile, ATL, and philosophy of international-mindedness are strongly present in the transversal competencies of the FNCC. Although there are some differences in the degree of emphasis on specific issues – namely technology and national identity – students or teachers moving between the two programmes would find a high level of consistency between the philosophical underpinnings.

Programme Structure

There are some similarities between the two programme structures; for example, both take a baccalaureate-style approach to encourage breadth of study, and both require students to study subjects from broadly similar subject areas. Additionally, both programmes allow students to specialise in particular subjects – the DP by differentiating between SL and HL, and the FNCC by allowing students to study both the common and the national optional studies for a particular subject, as well as additional optional credits within each.

However, there are significant structural dissimilarities that would make movement between the two programmes challenging for both students and teachers. The fact that the FNCC is typically three years in duration compared to the DP's two years is one important factor. Moreover, the number of curriculum components in each programme is quite different. The FNCC's 150-credit structure leads to a larger number of subjects being experienced by students, whereas the DP's six-subject structure leads to a smaller number of subjects. Also, the FNCC/GUSE does not require the completion of additional components to pass the qualification, while students in the DP must complete the TOK, CAS and the extended essay in order to obtain their diplomas. Finally, the FNCC provides students with the option to study additional subjects (known as general upper secondary diplomas) which are focused on assessing student's competence and independent interest in subject areas that are not included in the DP (e.g. home economics, crafts, media).

Entry Requirements

Both the DP and the FNCC present a flexible approach to entry requirements at the start of their programmes. The IB encourages students and teachers to consult subject guides around expected prior learning but does not provide fixed entry requirements. There are also no fixed entry requirements to enter GUSE in Finland – whilst 'the key criterion for admission is that the student has completed the comprehensive school syllabus',[142] any student with an equivalent completed syllabus and sufficient potential is eligible to apply. Nevertheless, each education provider may issue additional selection criteria, such as entrance exams, so the specific requirements may vary per school.[143]

[142] Ministry of Education and Culture, Finland. (n.d.). *General Upper Secondary Education.*
[143] Ministry of Education and Culture, Finland. (n.d.). *General Upper Secondary Education.*

Student Learning Pathways

Both programmes provide a significant level of optionality in relation to subjects studied and both require students to study subjects from a wide range of subject groupings. The approach to combining subject-specialisation with breadth is therefore fairly similar, however, the structural dissimilarities mean that the practical nature of student pathways are inevitably quite different. The same student looking at both programmes would have to make fairly different practical choices to achieve the specific subject balances required by each diploma, but both would enable that student to pursue subjects that interest them to a higher level than subjects that are less significant to their intended pathway.

Assessment Methods

Whereas the DP uses external terminal assessment to make up the majority of assessment in each individual subject, the FNCC does not make use of external assessment – instead, it uses flexible internal assessment to comprise the full weighting of assessment in all subjects.

Although this would seemingly make the two programmes weakly aligned, it should be noted that the flexibility of the internal assessment in the FNCC/GUSE could result in a practical student experience that is quite similar in some respects to the DP's assessment patterns. For instance, the type of skills assessed in each programme show broad alignment. Moreover, what little information is available on the FNCC's flexible assessment indicates that similar methods to the DP would be likely – e.g. laboratory work for science, oral work in languages, and performances in the arts subjects.

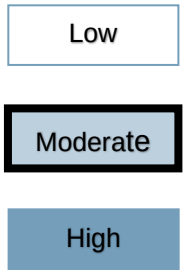
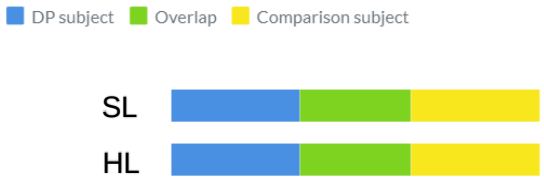
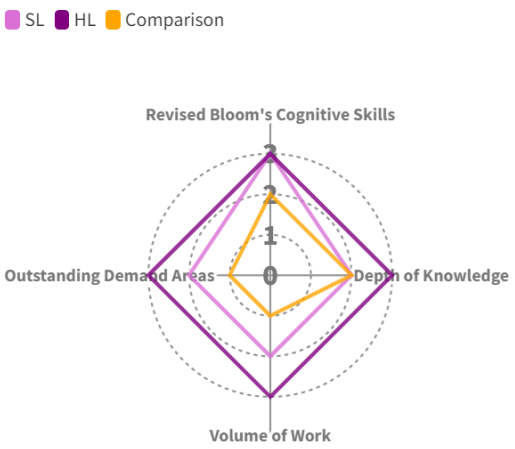
Summary

The structures of the two programmes are the most significant point of difference and the philosophical underpinnings are the most significant point of similarity. In all other respects, there are some notable differences, though with points of clear alignment with regard to how students would be likely to experience the programmes in practice.

6.2 Subject Level

This section provides visual summaries of the subject-level alignment between specific subjects within the DP and the respective comparison points in the FNCC. The summaries include key findings on learning outcomes alignment, content alignment and demand alignment, as per the key below:

Key:

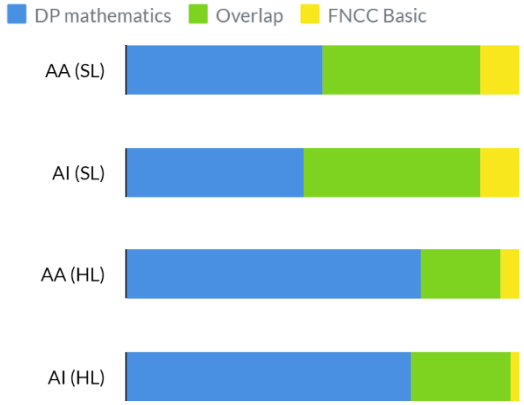
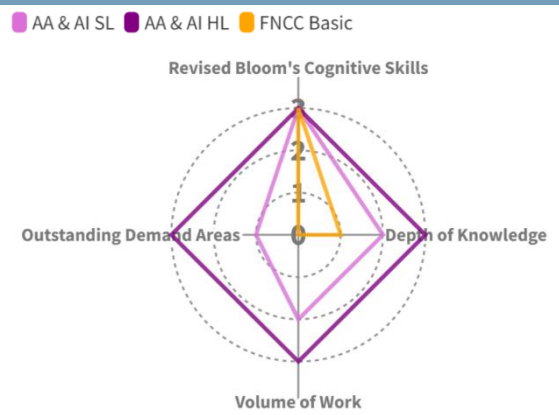
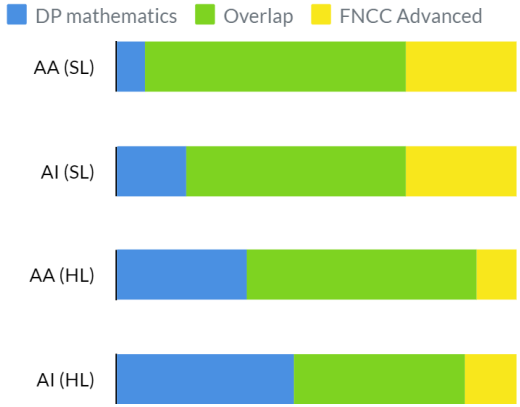
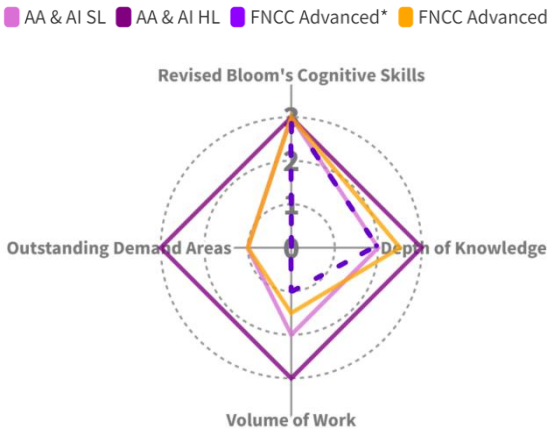
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Displays the name of the comparison subject	 This represents the learning outcome alignment between the DP subject and the comparison subject. A black border is placed around the selected judgement – 'Moderate' in this example.	 These bars represent the content alignment between the DP subject and the comparison. There is one bar showing alignment with SL content and another for HL content (inclusive of SL content). The **green** section of the bar represents the overlap of content between the subjects. The **blue** section represents content which was in the DP subject only. The **yellow** section represents content which was in the comparison subject only. Therefore, if, say, the blue section was longer than the yellow, this can be interpreted as DP subject having more content unique to itself than the comparison did. A large green bar would indicate that a substantial proportion of content overlaps between the DP and the comparison subject.	 This radar diagram displays the demand judgement scores for the comparison subject(s) and the DP subject – both SL and HL.

NB: Notably, the exact depth of the FNCC subjects' content is not possible to ascertain from the curriculum documentation, as each education provider prepares their own local curriculum based on the FNCC. Thus, while the analysis in this report is based on the FNCC documentation, the way in which the latter is implemented locally may vary significantly depending on the education provider.

6.2.1 Mathematics Alignment

The subject level alignment between the DP and FNCC mathematics subjects is represented below:

Figure 27: Visual representations of subject-level alignment (mathematics subjects)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Basic syllabus	Low Moderate **High**		
Advanced syllabus	Low Moderate **High**		

NB: For demand, the FNCC Advanced* refers to compulsory modules only, while FNCC Advanced represents the full FNCC advanced syllabus, including both compulsory modules and the additional optional modules combined.

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the FNCC syllabi learning outcomes is significant, as all DP themes are present in the FNCC.

- **Content alignment**: though the FNCC's basic syllabus has some overlapping content with DP SL, the latter surpasses it in breadth and depth. The FNCC's advanced syllabus is slightly more aligned with AA than AI, for both SL and HL. There is a reasonable amount of alignment with DP AA HL; however, based on the documented content (which may be further developed by each provider), the advanced syllabus has less breadth and depth than DP. Notably, students in the FNCC are not required to take optional modules and in practice may study a somewhat smaller volume of content. Without the optional modules, the breadth and depth of the advanced syllabus is more comparable to DP SL.

- **Demand alignment**: the FNCC basic syllabus is the least aligned with DP subjects in terms of demand, scoring less than DP SL for all categories except Bloom's cognitive skills. The advanced syllabus is more similar in demand to DP SL than DP HL, becoming more strongly aligned when all modules are studied, both compulsory and optional. All FNCC courses scored lower than the DP subjects for volume of work – though the lack of detail in FNCC documentation, with regard to depth of content, is a factor here.

The **key similarities** identified were the following:

- **Similarities in learning outcomes**: both the DP and FNCC set out general learning outcomes that are applicable to all mathematics courses within their respective programmes. All eight themes extracted from the DP are strongly present in the FNCC, hence the mathematics learning outcome themes of the DP and FNCC are highly aligned. Both detail a wide range of skills to be developed, which altogether demonstrate a holistic approach. Indeed, it is important to both the DP and FNCC that students not only learn mathematical skills, but also cultivate a genuine interest in exploring mathematics and learn transferable skills such as collaboration, independence, confidence, and perseverance. In addition to this, understanding and application, critical and creative thinking skills, making connections, communication, and technology are all present in the DP and FNCC. Furthermore, it is important in both curricula that students will explore the wider contexts of mathematics through appreciating historical and cultural perspectives, the universality of mathematics, and reflecting on how to solve local and global challenges that face the environment and humankind. Furthermore, the FNCC has a similarly strong emphasis on inquiry-based approaches, as they aim to develop students' confidence in taking investigative and experimental actions.

- **Similarities in content**: from the FNCC, the basic syllabus content has partial alignment with DP SL, covering some similar topics, though (based on the documented content covered – which may be further developed by schools) the FNCC basic syllabus content generally lacks the breadth and depth to be comparable with the IB

subjects. The advanced syllabus has more shared content with the DP curriculum. The compulsory modules alone have high alignment with DP SL content, covering a similar breadth and depth of topics. When the optional modules are included, the content of the advanced syllabus slightly surpasses DP SL in breadth and depth, though not enough to be comparable to DP HL. It can also be noted that alignment is slightly stronger with AA than AI.

- **Similarities in demand**: DP and FNCC both have the highest score for the presence of higher-order cognitive skills (taken from Bloom's Revised Taxonomy) and therefore have similar emphasis on analysis, evaluation, and creation in their learning outcomes. For the rest of the scores, the FNCC has higher similarity with the demand level of the DP SL than the DP HL, with the advanced syllabus scoring the same, or similar, for depth, volume, and outstanding areas as DP SL. Similarity with the DP SL is stronger when all compulsory and optional modules are studied from the advanced syllabus.

The **key differences** identified were the following:

- **Differences in learning outcomes:** the learning outcome themes of the DP and FNCC for mathematics are generally very similar. However, it can be noted that making connections within mathematics and modelling skills have stronger emphasis in the FNCC.

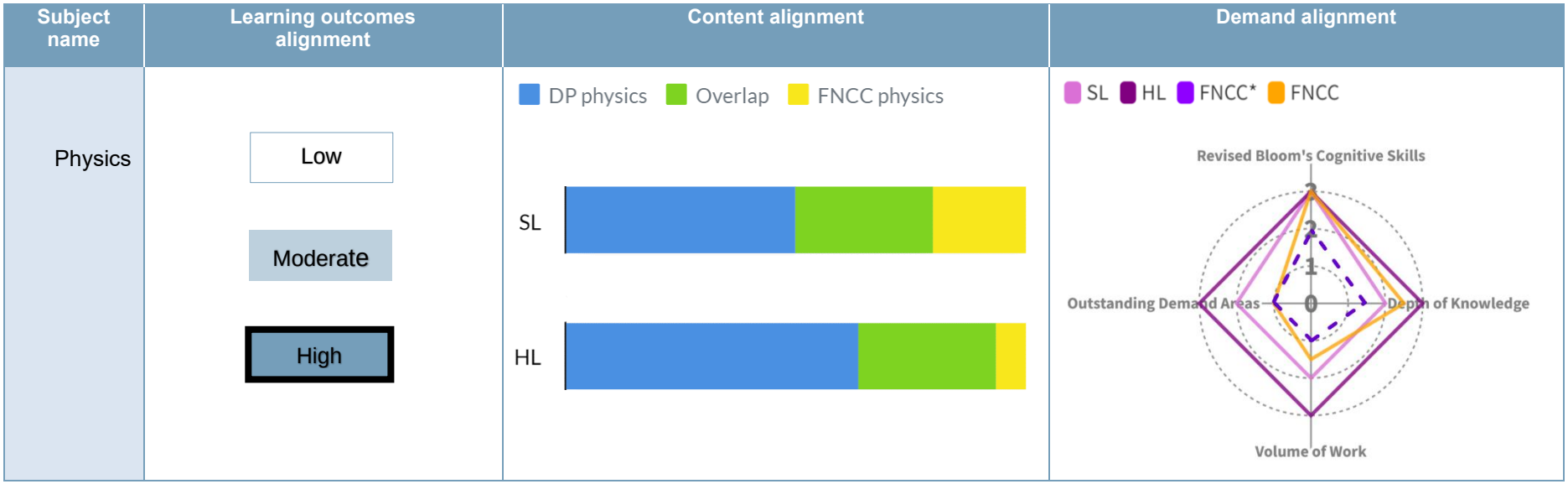
- **Differences in content:** there are key differences in the structure of the content between the DP and FNCC. Despite both offering two levels, the FNCC basic syllabus is not studied as part of advanced syllabus in the way that SL is studied as part of HL in the DP. Furthermore, the FNCC syllabi are structured into modules, some of which are optional and are not required to be studied, unlike the DP, which comprises compulsory content only. For content alignment, the basic syllabus has no alignment with AHL content and lacks the breadth and depth to be comparable to either SL or HL. For the advanced syllabus, there is only some alignment with AHL content, even when optional modules are included. Generally, the advanced syllabus has less breadth and depth than DP HL subjects according to the information available in the curriculum documentation.

- **Differences in demand:** aside from the score for Bloom's cognitive skills, the basic syllabus scores less than the DP SL in all categories. Furthermore, the advanced syllabus scores less than the DP HL in all other categories, especially for outstanding demand areas and volume of work, thus no course in the FNCC is highly aligned with the demand scores of the DP HL. Though, the capacity for schools to further develop content beyond the documented curriculum is a relevant contextual factor with respect to these judgements.

6.2.2 Physics Alignment

The subject-level alignment between the DP and FNCC physics is represented below:

Figure 28: Visual representations of subject-level alignment (physics)



NB: For demand, the FNCC* refers to compulsory modules only, while FNCC represents the full FNCC physics curriculum, including both compulsory modules and the additional optional modules combined.

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and FNCC physics is significant, with all themes extracted from the DP learning outcomes being present in the FNCC's learning outcomes.

- **Content alignment**: there is some content overlap between the DP and FNCC physics, with the latter containing a mixture of SL and AHL sub-topics. However, the FNCC describes the content coverage of these topics in far less detail than the DP, resulting in mostly 'partial' rather than 'full' sub-topic alignments. This is true also for alignment with the DP's experimental programme, with the FNCC only including limited detail on practical experiments and scientific inquiry. Despite some evidence of a wide range of topics being touched upon, the documented size of the FNCC content described is far smaller than DP HL, with the latter surpassing it in breadth and depth. The fact that only some SL and HL sub-topics are clearly included in the FNCC subjects results in relatively limited alignment with regard to content. However, FNCC physics content appears to be of a similar size to DP SL, provided that both compulsory and optional modules are studied.

- **Demand alignment**: the demand of FNCC physics varies depending on how many modules within this subject are taken. When considering only the compulsory modules, the demand of FNCC physics is surpassed in all demand categories by both SL and HL. When taking into account all modules (both compulsory and national optional modules), FNCC physics scores comparably to DP SL, scoring the same or similar in all categories.

The **key similarities** identified were the following:

- **Similarities in learning outcomes:** FNCC physics covers all learning outcome themes extracted from the DP, though some are more emphasised than others. Many are found within the 'task of the subject' and the 'transversal competences' sections of the curriculum. The FNCC physics places particular importance on the awareness of local and global problems, and creativity and critical thinking.

- **Similarities in content:** for both SL and AHL, there is some overlap in subject content with the FNCC physics curriculum, particularly within topics A. Space, time and motion, B. The particulate nature of matter, D. Fields and E. Nuclear and quantum physics. When it comes to SL sub-topics, the FNCC shows strong alignment with A.3 Work, energy and power and C.2 Wave model. Regarding AHL content, the FNCC shows considerable alignment with topics B. The particulate nature of matter and C. Wave behaviour, particularly sub-topic C.5 Doppler effect.

- **Similarities in demand:** when all modules (both compulsory and optional) of the FNCC physics syllabus are considered, there is reasonable alignment with the demand of the DP SL. Indeed, the FNCC physics received the same score for Bloom's higher order thinking skills as the DP SL and HL content, reflecting the similar focus on analysis, evaluation, and creation in their learning outcomes.

The **key differences** identified were the following:

- **Differences in learning outcomes:** the themes of applying necessary skills to carry out investigations and demonstrating knowledge that categorises science are not emphasised within the FNCC learning outcomes as extensively as in the DP. Instead, the FNCC learning outcomes are more centred around students developing skills that help them appreciate the impact of their every-day choices and take responsibility for their own actions.

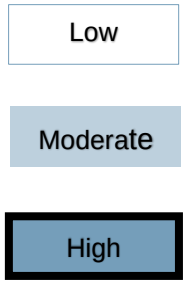
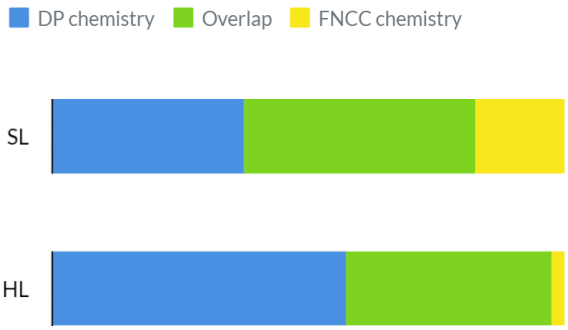
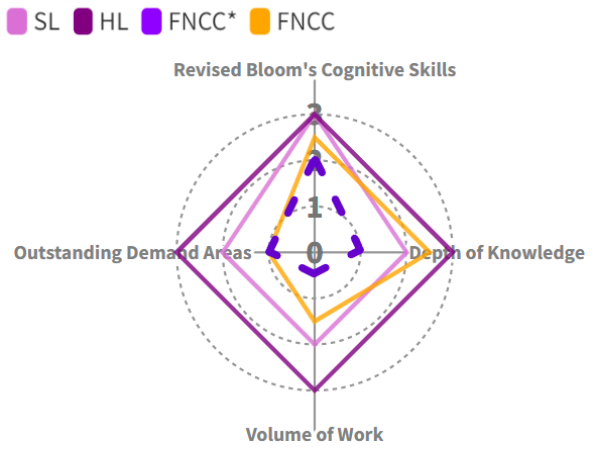
- **Differences in content:** regarding content in the DP SL, the FNCC physics curriculum does not include most of the content from topic C (Wave behaviour). There are also three other SL sub-topics which do not have clear presence in the FNCC: B.2 Greenhouse effect, D.1 Gravitational fields and E.5 Fusion and stars. Regarding AHL content, the FNCC content does not overlap with any components of topic D. Fields or topic E. Nuclear and quantum physics, and the sub-topic A.5 Galilean relativity is also absent. Overall, based on the information available in FNCC documentation, the FNCC does not go into the same level of depth as the DP (though it is possible that schools may go beyond what is presented there).

- **Differences in demand:** the FNCC compulsory physics course was given lower scores in all categories than the DP SL and HL physics. As to the FNCC compulsory and optional physics combined, these differed from both DP SL and HL regarding depth of knowledge, volume of work and outstanding demand areas. FNCC scored higher than SL for the depth of knowledge category, but it did not meet the score given to DP HL, whereas the categories of volume of work and outstanding demand areas were judged to be below both the SL and HL content.

6.2.3 Chemistry Alignment

The subject-level alignment between the DP chemistry and FNCC chemistry is represented below:

Figure 29: Visual representations of subject-level alignment (chemistry)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Chemistry			

NB: For demand, the FNCC* refers to compulsory modules only, while FNCC represents the full FNCC chemistry curriculum, including both compulsory modules and the additional optional modules combined.

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and FNCC chemistry is significant, with all themes extracted from the DP learning outcomes being present in the FNCC's learning outcomes.

- **Content alignment**: there is a reasonable amount of content overlap between the DP and FNCC chemistry, with the latter containing a mixture of SL and HL sub-topics. However, the FNCC describes the content coverage of these topics in far lesser detail than the DP, resulting in some 'partial' rather than 'full' sub-topic alignments, especially for HL sub-topics. This is true also for alignment with the DP's experimental programme, with the FNCC only including limited detail on practical experiments and scientific inquiry. Though the FNCC has some level of alignment with several DP sub-topics, a significant amount of SL and HL content is absent from the FNCC, especially within the sub-topics from Reactivity 3. What are the mechanisms of chemical change?. The fact that only some SL and HL sub-topics are clearly included in the FNCC subjects results in relatively limited content alignment between the DP and the FNCC. Overall, the documented volume of FNCC content is exceeded by DP HL, which has greater breadth and depth than the former. However, FNCC chemistry content appears to be of a similar size to that of DP SL, provided that both compulsory and optional modules are studied.

- **Demand alignment**: the demand of FNCC chemistry varies depending on how many modules within this subject are taken. When considering only the compulsory modules, the demand of FNCC chemistry is surpassed in all categories by both SL and HL. When taking into account all modules (both compulsory and national optional modules), FNCC chemistry scores comparably to DP SL, scoring the same or similar in all categories.

The key similarities identified were the following:

- **Similarities in learning outcomes:** FNCC chemistry covers all learning outcome themes extracted from the DP, though some are more emphasised than others. Many are found within the 'task of the subject' and the 'transversal competences' sections of the curriculum. The FNCC chemistry places particular importance on the awareness of local and global problems, and creativity and critical thinking.

- **Similarities in content:** for both SL and AHL, there are some overlaps in subject content with the FNCC chemistry curriculum. A reasonable number of SL topics are covered in the FNCC chemistry, particularly Structure 1. Models of the particulate nature of matter and Structure 2. Models of bonding and structure, whereas the FNCC only partially covers the content in the SL topic of Structure 3. Classification of matter. The FNCC also has some alignment with AHL content, having strong alignment for Structure 2.4. From models to materials, and partial alignment in several other topics.

- **Similarities in demand:** when all modules (both compulsory and optional) of the FNCC chemistry syllabus are considered, there is reasonable alignment with the demand of the DP SL. Indeed, the overall FNCC chemistry syllabus scores similarly to DP SL for Bloom's cognitive skills, depth of knowledge, and volume of work.

The **key differences** identified were the following:

- **Differences in learning outcomes:** the themes of applying necessary skills to carry out investigations and demonstrating knowledge that categorises science are not emphasised within the FNCC learning outcomes as extensively as in the DP. Instead, the FNCC learning outcomes are more centred around students developing skills that help them appreciate the impact of their every-day choices and take responsibility for their own actions.

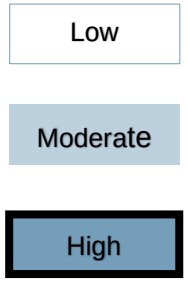
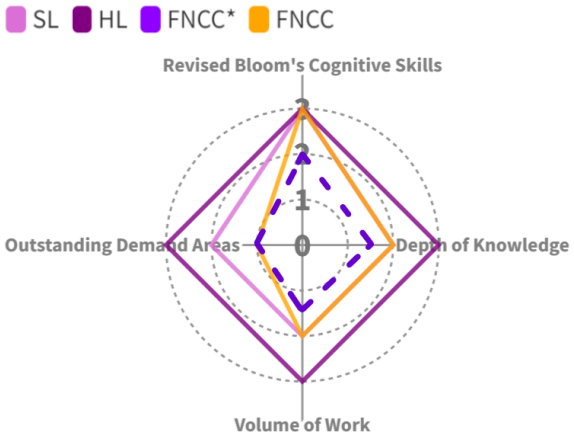
- **Differences in content:** with the exception of Structure 3. Classification of matter, the there are a number of sub-topics within all other SL topics which are not covered in the FNCC. Additionally, the FNCC also does not cover a number of AHL sub-topics, showing particularly low alignment with those within Structure 2. Models of bonding and structure and Reactivity 3. What are the mechanisms of chemical change?. Overall, based on the information available in the FNCC documentation, the FNCC chemistry curriculum is not as broad or as deep as the DP (though schools may go beyond this in practice).

- **Differences in demand:** the FNCC compulsory chemistry course scores lower in all categories than the DP SL and HL chemistry. The FNCC compulsory and optional chemistry combined scored less than HL in all categories, reflecting limited alignment with the demand of DP HL overall. The most significant difference in scores came from the outstanding areas of subject demand category, with the FNCC scoring notably less than both SL and HL.

6.2.4 Biology Alignment

The subject-level alignment between the DP biology and FNCC biology is represented below:

Figure 30: Visual representations of subject-level alignment (biology)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Biology			

NB: For demand, the FNCC* refers to compulsory modules only, while FNCC represents the full FNCC biology curriculum, including both compulsory modules and the additional optional modules combined.

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and FNCC biology is significant, with all themes extracted from the DP learning outcomes being present in the FNCC's learning outcomes.

- **Content alignment**: there is a reasonable amount of content overlap between DP and FNCC biology, with the latter comprising of mostly SL sub-topics and some HL sub-topics. However, the FNCC describes the content coverage of these topics in far less detail than the DP, resulting in mostly 'partial' rather than 'full' sub-topic alignments. This is also true for alignment with the DP's experimental programme, with the FNCC only including limited detail on practical experiments and scientific inquiry. Furthermore, despite some overlap in several topic areas, a significant amount of both SL and HL content is absent from the FNCC, especially sub-topics from B. Form and function. The fact that only some SL and HL sub-topics are clearly included in the FNCC subjects results in relatively limited content alignment between the DP and FNCC. Overall, the FNCC's volume of content is exceeded by DP HL, which has greater breadth and depth than the former. However, FNCC biology content appears to be of a similar size to DP SL, provided that both compulsory and optional modules are studied.

- **Demand alignment**: the demand of FNCC biology varies depending on how many modules within this subject are taken. When considering only the compulsory modules, the demand of FNCC biology is surpassed by SL to a relatively small degree, and by HL to a larger degree. When taking into account all modules (both compulsory and national optional modules), FNCC biology scores comparably to DP SL, scoring the same in all categories except outstanding areas, in which it received a slightly lower score.

The **key similarities** identified were the following:

- **Similarities in learning outcomes:** FNCC biology covers all learning outcome themes extracted from the DP, though some are more emphasised than others. Many are found within the 'task of the subject' and the 'transversal competences' sections of the curriculum. The FNCC biology places particular importance on the awareness of local and global problems, and creativity and critical thinking.

- **Similarities in content:** for SL, the FNCC shows strong alignment with most sub-topics of topic A. Unity and diversity, and partial alignment with all sub-topics within of topics C. Interaction and independence and D. Continuity and change. There is also partial alignment between the FNCC and some of the DP AHL sub-topics, though these are not covered in comparable depth.

- **Similarities in demand:** when all modules (both compulsory and optional) of the FNCC biology syllabus are considered, there is reasonable alignment with the demand of the DP SL. Indeed, the FNCC received the same score as the DP SL in three categories: Bloom's, depth of knowledge and volume of work.

The **key differences** identified were the following:

- **Differences in learning outcomes:** the themes of applying necessary skills to carry out investigations and demonstrating knowledge that categorises science are not emphasised within the FNCC learning outcomes as extensively as in the DP. Instead, the FNCC learning outcomes are more centred around students developing skills that help them appreciate the impact of their everyday choices and take responsibility for their own actions – e.g. students' understanding the importance of biodiversity and taking an active approach to making sustainable choices.

- **Differences in content:** for SL and AHL content, most of topic B. Form and function was not found to overlap with the FNCC biology curriculum. Regarding AHL content, roughly half of the sub-topics within each key topic are absent from the FNCC, and those that are included are not covered in comparable depth. Thus, based on the information available in FNCC documentation, the FNCC does not go into the same level of depth as the DP (though it is possible that schools may go beyond what is presented there).

- **Differences in demand:** the FNCC compulsory biology course scored lower than the DP SL and HL course content in all areas. As to the FNCC compulsory and optional biology combined, the scores were similar to those of the DP SL, apart from outstanding areas of subject demand, for which the FNCC scored lower. Regarding the DP HL, the FNCC scored lower than the former for volume of work, outstanding areas of subject demand and depth of knowledge.

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Appendix A

This Appendix provides further detail on the criteria utilised by Ecctis' experts and external panel members with subject expertise to measure demand for each of the subjects analysed in this study.

Demand Profile – Subject-level Judgement

- **Revised Bloom's cognitive** skills score (0-3): this is an overall score of course demand, based entirely on a review of learning outcomes. Levels have been defined based on increasing emphasis on Bloom's Higher Order Thinking Skills.

    - Level 0 – remembering and understanding: learning outcomes (as well as assessment and content) are primarily focused on recall and understanding, with limited or no evidence of higher order thinking skills.
    - Level 1 – applying: learning outcomes (as well as assessment and content) comprise a mix of recall-, understanding- and application-focused objectives, with only limited presence of higher order thinking skills.
    - Level 2 – analysing: learning outcomes (as well as assessment and content) comprise a mix of recall-, understanding and application-focused goals but also feature a substantial focus on analysis. Learning outcomes can also potentially feature some (though limited) evidence of evaluation and creation-focused goals.
    - Level 3 – evaluating and creating (or synthesising): learning outcomes (as well as assessment and content) feature a predominant focus on analysis-, evaluation- and creation/synthesis.

- **Depth of knowledge** (adapted from Webb's) score (0-3): this is an overall score evaluating the depth of knowledge or complexity of knowledge required by curriculum standards and expectations. The score is focused on subject content and learning outcomes, complemented by assessment where relevant/possible. Levels have been defined based on the level of detail studied per topic, as well as the levels of thinking described in Webb's Depth of Knowledge framework.

    - Level 0 – All or most topics are studied in limited detail (pre-upper secondary level). Only basic pre-requisite knowledge is required in order to grasp ideas. The level of cognitive complexity of the information students are expected to know is low (e.g. many tasks may require recall and reproduction of information such as facts, definitions, terms, or simpler procedures – acquired knowledge).
    - Level 1 – Some topics are studied in considerable detail. Moderate levels of pre-requisite knowledge are required in order to grasp ideas in some topics. The level of cognitive complexity of the information students are expected to know is low to moderate (e.g. many tasks may require engagement of some mental processing beyond habitual responses, including comparison and basic reasoning – knowledge application).

  - Level 2 – Most topics are studied in considerable detail. Considerable pre-requisite knowledge is required in order to grasp ideas in some topics. The level of cognitive complexity of the information students are expected to know is average to high (e.g. some tasks require complex reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. The cognitive demands are often complex and abstract – analysis).
  - Level 3 – All or most topics are studied in very high detail. Considerable pre-requisite knowledge is required in order to grasp ideas in most topics. The level of cognitive complexity of information students are expected to know is mostly high (e.g. many tasks may require complex reasoning, planning, developing, information synthesis, interpretation of data for problem solving, and thinking most likely over an extended period – extended thinking).

- **Volume of work** score (0-3): this is a trifactor score, considering breadth of content and depth of content, evaluated against the programme's specified timeframe. The three factors – breadth, depth, and time – were all considered in defining the levels.

  - Level 0 – light: small number of themes and sub-themes covered; a significant majority of time is spent on straightforward or basic themes; generous time allocation per theme.
  - Level 1 – moderate: typical number of themes and sub-themes covered; more time spent on conceptually complex themes compared to Level 1 (though majority of time still spent on themes of basic depth); standard time allocation per theme.
  - Level 2 – moderate heavy: typical to high number of themes and sub-themes covered; a significant proportion of time spent on issues beyond basic conceptual depth; standard to short time allocation per theme.
  - Level 3 – heavy: high number of themes and sub-themes covered; a large proportion of time spent on issues beyond basic conceptual depth; short time allocation per theme.

- **Outstanding areas of subject demand** score (0-3): this score reflects the number of content areas typically viewed as more challenging and/or conducive to intellectual stretching of learners. Levels have been defined on a scale of increasing presence of 'stretch areas'.

  - Level 0 – no stretch areas (0)
  - Level 1 – few stretch areas (1-2)
  - Level 2 – a significant number of stretch areas (3-4)
  - Level 3 – a high number of stretch areas (>4)

Appendix B

Learner profile	Approaches to learning	Approaches to teaching	International-mindedness
Inquirers: We nurture our curiosity, developing skills for inquiry and research. We know how to learn independently and with others. We learn with enthusiasm and sustain our love of learning throughout life. **Knowledgeable**: We develop and use conceptual understanding, exploring knowledge across a range of disciplines. We engage with issues and ideas that have local and global significance. **Thinkers**: We use critical and creative thinking skills to analyse and take responsible action on complex problems. We exercise initiative in making reasoned, ethical decisions. **Communicators**: We express ourselves confidently and creatively in more than one language and in many ways. We collaborate effectively, listening carefully to the perspectives of other individuals and groups. **Principled**: We act with integrity and honesty, with a strong sense of fairness and justice, and with respect for the dignity and rights of people everywhere. We take responsibility for our actions and their consequences. **Open Minded**: We critically appreciate our own cultures and personal histories, as well as the values and traditions of others. We seek and evaluate a range of points of view, and we are willing to grow from the experience.	In all IB programmes, there are five categories of skills including: **Thinking skills:** including areas such as critical thinking, creative thinking, and ethical thinking **Research skills:** including skills such as comparing, contrasting, validating, and prioritizing information **Communication skills:** including skills such as written and oral communication, effective listening, and formulating arguments **Social skills:** including areas such as forming and maintaining positive relationships, listening	In all IB programmes, teaching is: **Based on inquiry:** A strong emphasis is placed on students finding their own information and constructing their own understandings. **Focused on conceptual understanding:** Concepts are explored in order to both deepen disciplinary understanding and to help students make connections and transfer learning to new contexts. **Developed in local and global contexts:** Teaching uses real-life contexts and examples, and students are encouraged to process new information by connecting it to their own experiences and to the world around them. **Focused on effective teamwork and collaboration:** This includes promoting teamwork and collaboration between students, but also refers to the collaborative relationship between teachers and students.	The aim of all IB programmes is to develop internationally minded people who recognize their common humanity and shared guardianship of the planet. Central to this aim is international-mindedness. International-mindedness is a multifaceted concept that captures a way of thinking, being and acting characterised by an openness to the world and a recognition of our deep interconnectedness to others. To be open to the world, we need to understand it. IB programmes therefore provide students with opportunities for sustained inquiry into a range of local and global issues and ideas. This willingness to see beyond immediate situations and boundaries is essential as globalization and emerging technologies continue to blur traditional distinctions between the local, national and international. An IB education fosters international-mindedness by helping students reflect on their own perspective, culture and identities, as well as those of others. By engaging with diverse beliefs, values and experiences, and by learning to think and collaborate across cultures and disciplines, IB learners gain the understanding necessary to make progress towards a more peaceful world.

Caring: We show empathy, compassion, and respect. We have a commitment to service, and we act to make a positive difference in the lives of others and in the world around us. **Risk-Takers**: We approach uncertainty with forethought and determination; we work independently and cooperatively to explore new ideas and innovative strategies. We are resourceful and resilient in the face of challenges and change. **Balanced**: We understand the importance of balancing different aspects of our lives – intellectual, physical, and emotional – to achieve well-being for ourselves and others. We recognize our interdependence with other people and with the world in which we live. **Reflective**: We thoughtfully consider the world and our own ideas and experience. We work to understand our strengths and weaknesses in order to support our learning and personal development.	skills, and conflict resolution **Self-management skills:** including both organizational skills, such as managing time and tasks, and affective skills, such as managing state of mind and motivation.	**Designed to remove barriers to learning:** Teaching is inclusive and values diversity. It affirms students' identities, and aims to create learning opportunities that enable every student to develop and pursue appropriate personal goals. **Informed by assessment:** Assessment plays a crucial role in supporting, as well as measuring, learning. This approach also recognizes the crucial role of providing students with effective feedback.	An IB education further enhances the development of international-mindedness through multilingualism. All IB programmes require students to study, or study in, more than one language. This is because we believe that communicating in more than one language helps students to appreciate that his or her own language, culture and world view are just one of many. In this way, it provides excellent opportunities to develop intercultural understanding and respect. International-mindedness is also encouraged through a focus on global engagement and meaningful service with the community. These elements challenge students to critically consider power and privilege, and to recognize that they hold this planet and its resources in trust for future generations. They also highlight the focus on action in all IB programmes: a focus on moving beyond awareness and understanding to engagement, action and bringing about meaningful change to make a more peaceful and sustainable world for everyone.

Appendix C

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Task brief – Expert Demand Panel – [Subject]

For each subject, highlight in yellow the descriptor(s) deemed to best fit each demand category, using the following criteria (please refer to the demand tables for descriptors of the levels):

- **Revised Bloom's cognitive skills** score (0-3): this is an overall score of course demand, based entirely on a review of learning outcomes. Levels have been defined based on increasing emphasis on Bloom's Higher Order Thinking Skills.

- **Depth of knowledge** (adapted from Webb's) score (0-3): this is an overall score evaluating the depth of knowledge or complexity of knowledge required by curriculum standards and expectations. The score is focused on subject content and learning outcomes, complemented by assessment where relevant/possible. Levels have been defined based on the level of detail studied per topic, as well as the levels of thinking described in Webb's Depth of Knowledge framework.

- **Volume of work** score (0-3): this is a trifactor score, considering breadth of content and depth of content, evaluated against the programme's specified timeframe. The three factors – breadth, depth and time – were all taken into account in defining the levels.

- **Outstanding areas of subject demand** score (0-3): this score reflects the number of content areas typically viewed as more challenging and/or conducive to intellectual stretching of learners. Levels have been defined on a scale of increasing presence of 'stretch areas'.

Demand Judgements – [Subject]

Table 25: [Subject]

Demand Judgement	Score Descriptors (highlight the best-fit descriptor)	Judgement and Key Evidence
Revised Bloom's Cognitive Skills[144]	Level 0 – remembering and understanding: learning outcomes are primarily focused on recall and understanding, with limited or no evidence of higher order thinking skills.	
	Level 1 – applying: learning outcomes (as well as assessment and content) comprise a mix of recall-, understanding- and application-focused objectives, with only limited presence of higher order thinking skills.	
	Level 2 – analysing: learning outcomes (as well as assessment and content) comprise a mix of recall-, understanding and application-focused goals but also feature a substantial focus on analysis. Learning outcomes can also potentially feature some (though limited) evidence of evaluation and creation-focused goals.	
	Level 3 – evaluating and creating (or synthesising): learning outcomes feature a predominant focus on analysis-, evaluation- and creation/synthesis.	
Depth of Knowledge[145]	Level 0 – All or most topics are studied in limited detail (pre-upper secondary level). Only basic pre-requisite knowledge is required in order to grasp ideas. The level of cognitive complexity of the information students are expected to know is low (e.g. many tasks may require recall and reproduction of information such as facts, definitions, terms, or simpler procedures – acquired knowledge).	
	Level 1 – Some topics are studied in considerable detail. Moderate levels of pre-requisite knowledge are required in order to grasp ideas in some topics. The level of cognitive complexity of the information students are expected to know is low to moderate (e.g. many tasks may require engagement of some mental processing beyond habitual responses, including comparison and basic reasoning – knowledge application).	
	Level 2 – Most topics are studied in considerable detail. Considerable pre-requisite knowledge is required in order to grasp ideas in some topics. The level of cognitive complexity of the information students are expected to know is average to high (e.g. some tasks require complex reasoning, planning, using evidence, and a higher level of thinking than the previous two	

[144] Evidence pool: Learning outcomes
[145] Evidence pool: Learning outcomes, subject content, assessment types

Demand Judgement	Score Descriptors (highlight the best-fit descriptor)	Judgement and Key Evidence
	levels. The cognitive demands are often complex and abstract – analysis).	
	Level 3 – All or most topics are studied in very high detail. Considerable pre-requisite knowledge is required in order to grasp ideas in most topics. The level of cognitive complexity of information students are expected to know is mostly high (e.g. many tasks may require complex reasoning, planning, developing, information synthesis, interpretation of data for problem solving, and thinking most likely over an extended period of time – extended thinking).	
Volume of work[146]	Level 0 – light: small number of themes and sub-themes covered; a significant majority of time is spent on straightforward or basic themes; generous time allocation per theme.	
	Level 1 – moderate: typical number of themes and sub-themes covered; more time spent on conceptually complex themes compared to Level 1 (though majority of time still spent on themes of basic depth); standard time allocation per theme.	
	Level 2 – moderate heavy: typical to high number of themes and sub-themes covered; a significant proportion of time spent on issues beyond basic conceptual depth; standard to short time allocation per theme.	
	Level 3 – heavy: high number of themes and sub-themes covered; a large proportion of time spent on issues beyond basic conceptual depth; short time allocation per theme.	
Outstanding areas of subject demand[147]	Level 0 – no stretch areas (0)	
	Level 1 – few stretch areas (1-2)	
	Level 2 – a significant number of stretch areas (3-4)	
	Level 3 – a high number of stretch areas (>4)	

[146] Evidence pool: Subject content; assessment types and number; course duration; time allocated per topic/sub-topic (where available).
[147] Evidence pool: Subject content.