DP Country Alignment Studies: Alignment of the Diploma Programme with the Victorian Certificate of Education (VCE)

Submitted by Ecctis to the IB

Commercial in confidence

October 2022

Ecctis

Acronyms

AA	mathematics: analysis and approaches
AHL	additional higher level
AI	mathematics: applications and interpretation
ATAR	Australian Tertiary Admission Rank
ATL	approaches to teaching and learning
CAS	creativity, activity, service
CP	Career-related Programme
DP	Diploma Programme
FM	Foundation Mathematics
FRM	Further Mathematics
GAT	General Achievement Test
GM	General Mathematics
HL	higher level
IB	International Baccalaureate
IBO	International Baccalaureate Organisation
LO	Learning Outcome
MCQ	Multiple Choice Question
MM	Mathematical Methods
MYP	Middle Years Programme
PYP	Primary Years Programme
RQ	Research Question
SAC	school-assessed coursework
SAT	school-assessed tasks
SL	standard level
SM	Specialist Mathematics

TOK	theory of knowledge
USA	United States of America
VCAA	Victorian Curriculum and Assessment Authority
VCE	Victorian Certificate of Education
VET	Vocational Education and Training
VM	Vocational Major
WIAIBE	What is an IB education?

Contents

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 Victoria, Australia. The comparison qualification in question is the Victorian Certificate of Education (VCE).

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 Victoria 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 regards 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 regards 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 VCE, 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 the VCE 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 student learning pathways allowed by the two programmes are the most significant point of difference and the assessment the most significant point of similarity. In all other respects, there are some notable differences, though with points of considerable alignment with regards to how students likely experience the programmes in practice. Key similarities and differences include:

- **Philosophical underpinnings**: significant overlap was found between the VCE's and DP's philosophical underpinnings, with both being guided by principles of inclusion and diversity, and both prioritising the development of conceptual thought and higher-order thinking skills in students. Notably, the DP places a greater emphasis on developing students' communication and collaborative competence than the VCE.

- **Programme structure**: both the DP and VCE are two-year programmes that target the completion of an overarching diploma, offer significant levels of optionality, and typically comprise a similar number of subjects, though the VCE is more flexible than the DP in terms of subject choice.

- **Entry requirements**: both the DP and the VCE present a flexible approach to entry requirements at the start of their programmes. While neither has fixed entry requirements, when it comes to subject choice the VCE advises students to do either

[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).

or both Units 1 and 2 of a subject before attempting Unit 3 (or have equivalent experience), while the DP advises their students to consult subject guides around expected prior learning.

- **Student learning pathways**: both programmes enable students to pursue subjects that interest them to a higher level than subjects that are less significant to their intended pathway. However, the degree of specialisation allowed in the VCE is higher than in the DP, since, with exception of the requirement to study three units from the English group, students are allowed to choose any other subjects regardless of their subject group. In contrast, the DP typically requires students to study at least one subject from each of its six subject groups.

- **Assessment methods**: external terminal assessment makes up the majority of assessment in each individual subject in both the VCE and the DP. Although internal assessment is given greater weighting in the VCE (between 34%-50%) than in the DP (between 20-25%), the methods of assessment are broadly aligned and similarly prioritise the development of higher-order thinking skills.

Subject-level

In this study, Ecctis carried out subject-level comparative analysis between the DP and the VCE in mathematics, physics, chemistry, biology and history, focusing on the following DP and comparison subjects:

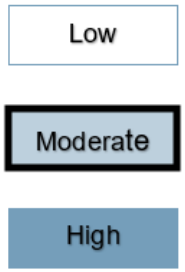
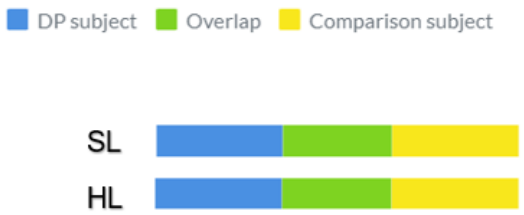
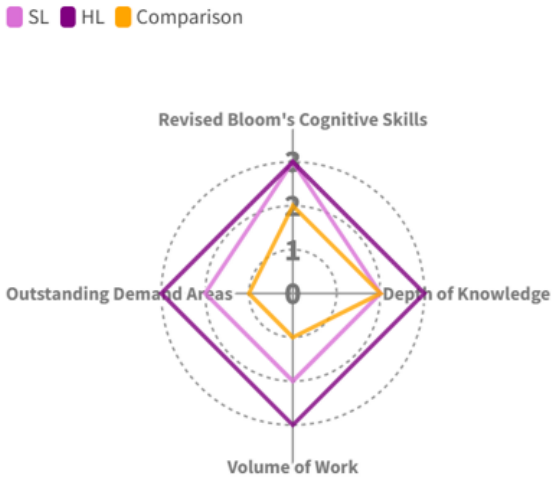
Table: Subject areas for comparison of the DP and the VCE curricula

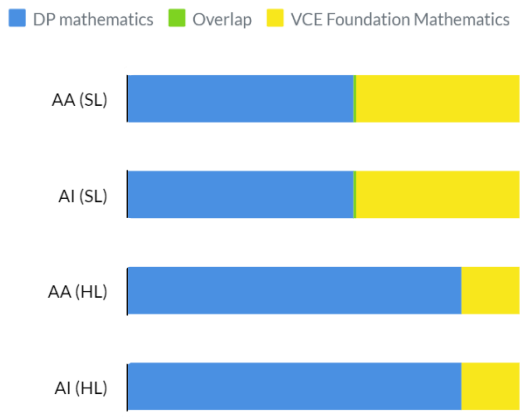
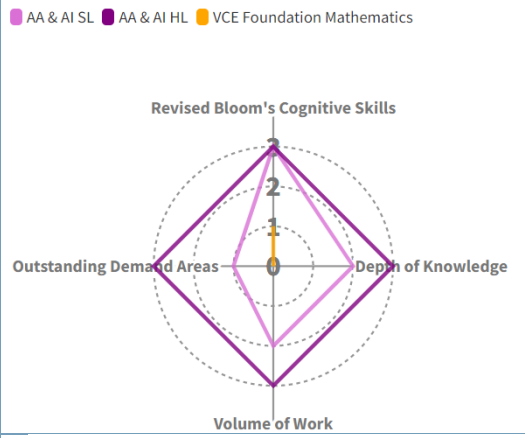
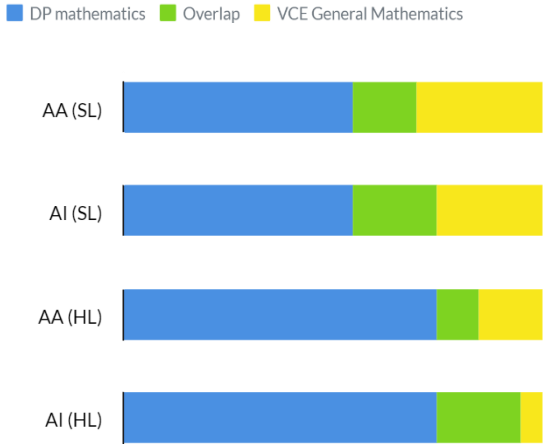
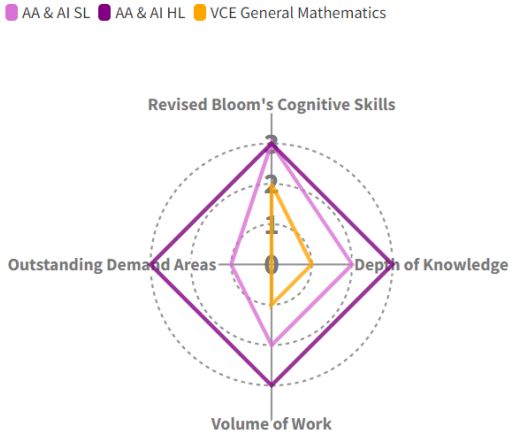
DP subject (group)	**Victoria (Australia) subjects**
SCIENCES	
biology SL & HL	biology
chemistry SL & HL	chemistry
physics SL & HL	physics
MATHEMATICS	
mathematics: analysis and approaches (AA) SL & HL	Foundation Mathematics (FM) General Mathematics (GM) Further Mathematics (FRM) Mathematical Methods (MM) Specialist Mathematics (SM)
mathematics: applications and interpretation (AI) SL & HL	
HISTORY	
history SL & HL	history

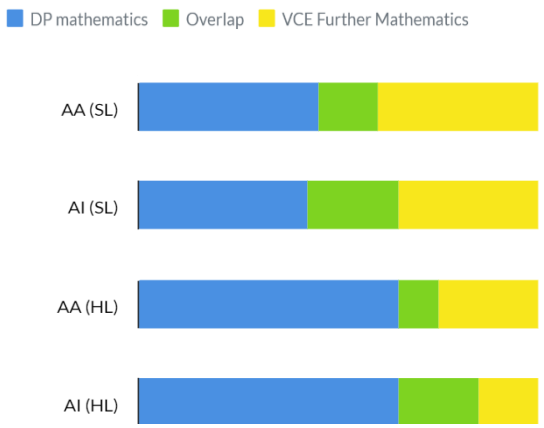
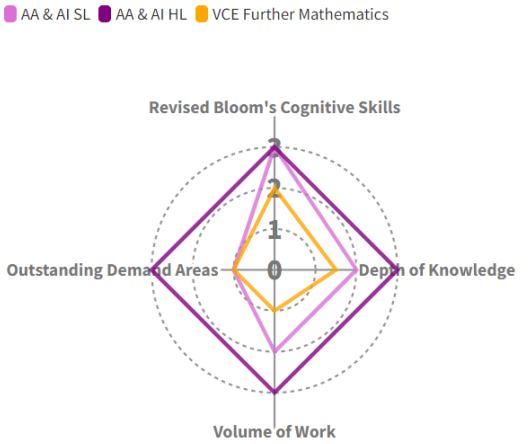
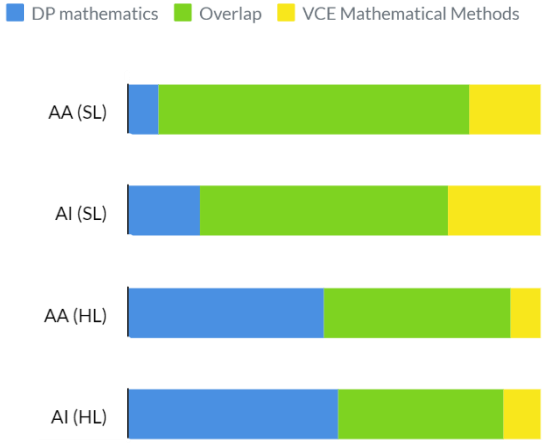
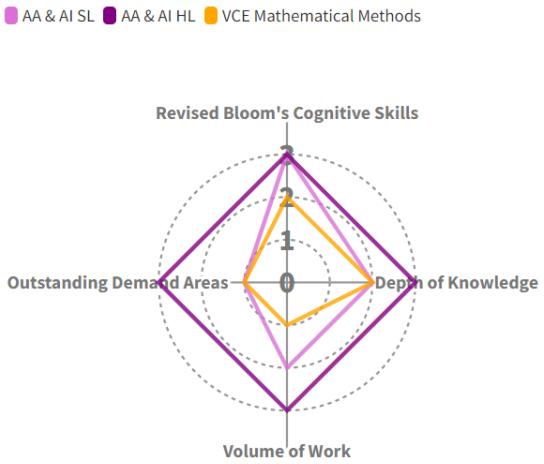
The findings from the subject-level analysis are summarised in the tables below:

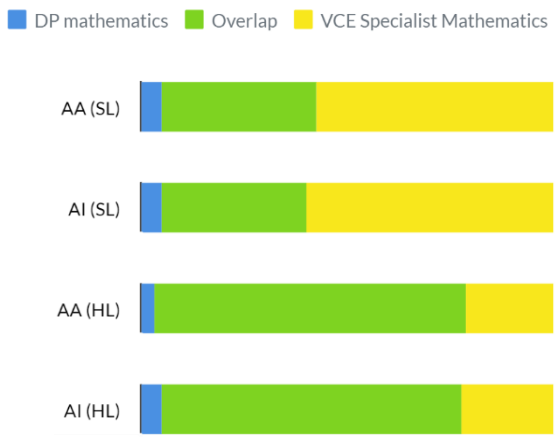
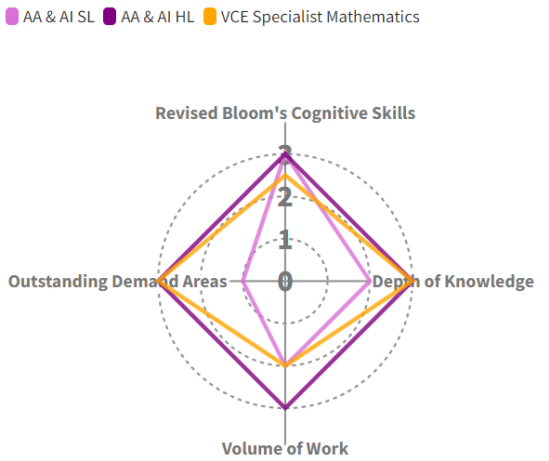
Figures: Visual representations of alignment between DP subjects and comparison subjects

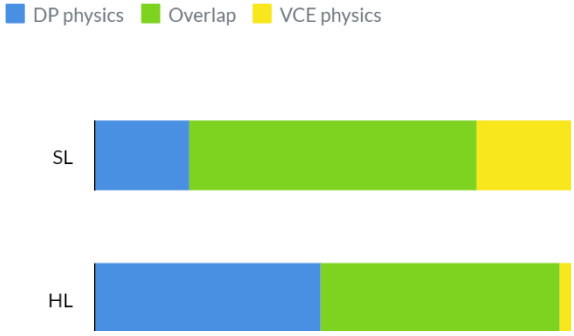
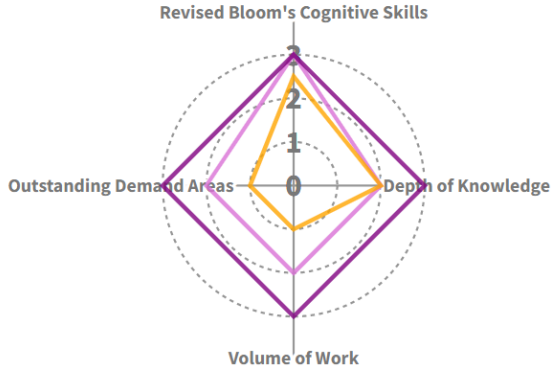
Key:

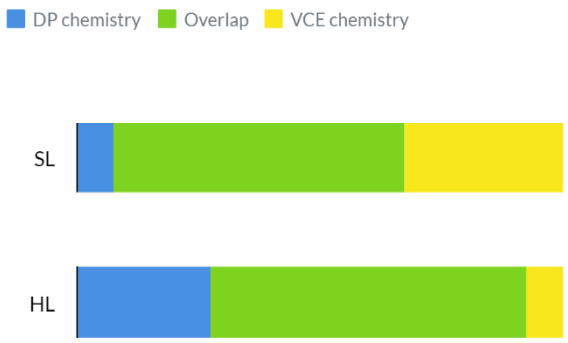
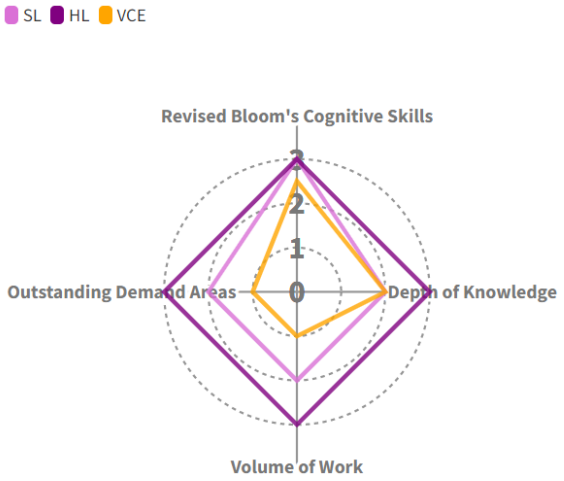
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Displays the name of the comparison subject	 This represents the learning outcome alignment between the DP subject and the comparison subject. A black border is placed around the selected judgement – 'Moderate' in this example.	 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.

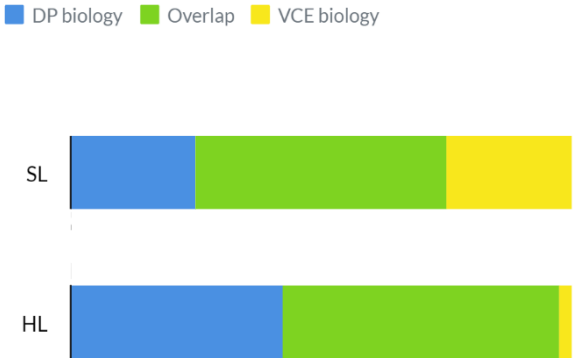
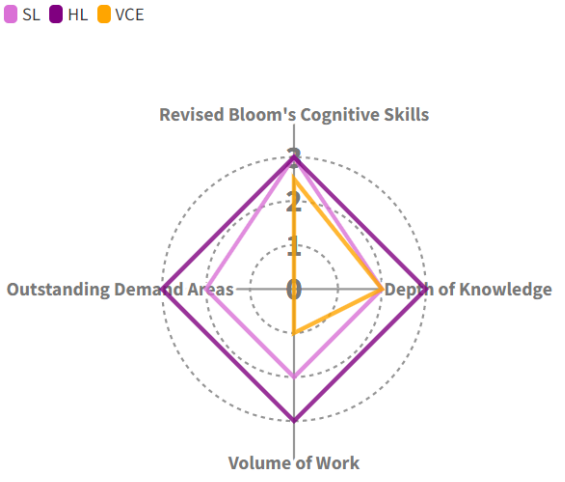
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Foundation Mathematics (FM)	Low Moderate High		
General Mathematics (GM)	Low Moderate High		

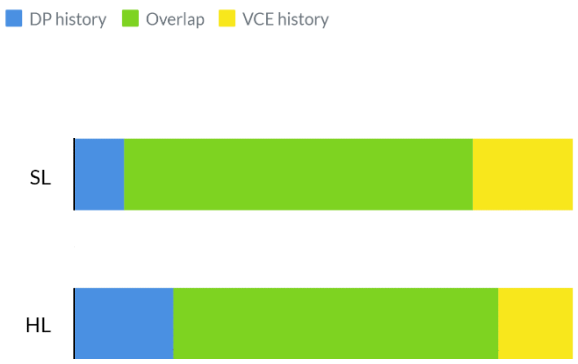
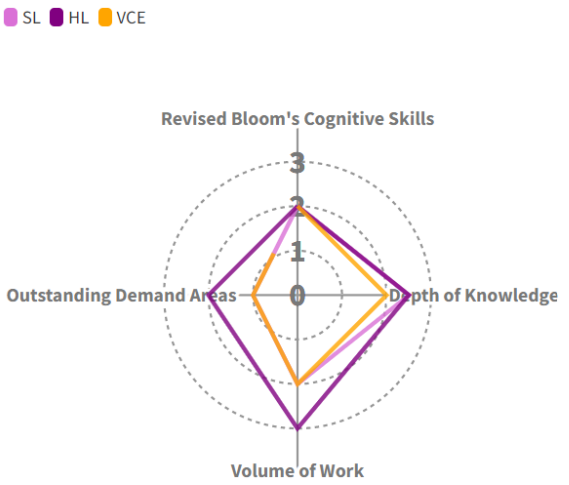
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Further Mathematics (FRM)	Low Moderate High		
Mathematical Methods (MM)	Low Moderate High		

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Specialist Mathematics (SM)	Low **Moderate** High		

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

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

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

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

As well as alignment judgements, the analysis also uncovered various similarities and differences between the DP and comparison subjects. Key highlights are summarised below.

Mathematics

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the VCE units' learning outcomes is varied. For Foundation Mathematics, General Mathematics, and Further Mathematics the alignment was low, increasing to moderate for Mathematical Methods and Specialist Mathematics. No courses are considered to have high alignment with the DP's learning outcomes.

- **Content alignment**: the level of content alignment between DP mathematics subjects and VCE mathematics subjects varied. Greater overlap is found with courses offering Units 3 & 4 than with those offering Units 1 & 2 only, namely Foundation Mathematics and General Mathematics. Further Mathematics, though offering Units 3 & 4, also has limited alignment with DP subjects, though slightly more with AI than AA, due to its applied nature. Mathematical Methods has strong alignment with DP SL content, especially AA, though limited overlap with DP HL, which exceeds Mathematical Methods content in breadth and depth. Finally, Specialist Mathematics has significant overlap with both HL subjects, but goes further in the breadth of content it covers – while both Specialist Mathematics and HL cover content that the other does not, the proportion of content covered by Specialist Mathematics that is not in HL is higher than the content covered by HL but not by Specialist Mathematics.

- **Demand alignment**: with the exception of Specialist Mathematics, all VCE subjects are surpassed by the demand of DP SL mathematics (both AA and AI). Foundation Mathematics and General Mathematics score considerably lower in all categories, whilst Further Mathematics and Mathematical Methods both score lower for volume of work and cognitive skills but are generally more comparable to SL. DP HL considerably surpasses in demand all subjects except Specialist Mathematics, which is more comparable due to scoring the same, or similar, in all categories except volume of work.

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 VCE science subjects is significant, with most themes extracted from the DP learning outcomes being present in the VCE's learning outcomes. Indeed, the learning outcomes of the VCE's science courses similarly focus on developing skills of scientific inquiry, technological skills, application, creative and critical thinking, awareness of global issues, environmental and societal implications. However, development of conceptual understanding is only an implicit theme in the learning outcomes of the VCE science courses, rather than explicit.

- **Content alignment**: there is significant topic and sub-topic overlap between the VCE and DP science courses, with the VCE courses covering the majority of content included at SL, some HL-only sub-topics that are not present in SL, and a small portion of unique content not present in either the SL nor the HL. All three DP HL science courses, on the other hand, go beyond the VCE courses in content breadth and depth.

- **Demand alignment**: the demand of the VCE science courses is closer to that of the DP science SL courses, though the latter feature more stretch areas and were judged to have a higher volume of work. The DP HL courses were judged to be more demanding than the VCE courses, featuring greater depth of knowledge, a higher volume of work, and additional stretch areas.

History

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and VCE history was found to be high, with all themes extracted from the DP history learning outcomes being present in the VCE's history learning outcomes. Some smaller differences are identifiable at the level of detailed consideration of the practical implications of learning outcomes.

- **Content alignment**: from a thematic perspective, there is substantial overlap in the content covered between VCE history and DP history at both SL and HL. Although each has unique content areas in terms of topics, periods, and regions, the same key approaches and themes are largely shared. There is slightly less overlap between VCE history and DP history HL (compared to SL), as the HL 'Depth studies' options contain more unique content and also reduce the amount of unique VCE content due to the option to study the history of Oceania. This comparison is complex, however, due to both the DP and VCE offering flexible pathways of unit/topic choices to students.

- **Demand alignment**: VCE history has a similar demand profile to DP SL history, though with a slightly lower score for depth of knowledge. DP HL history demand exceeds that of VCE history in all areas except the score for Bloom's cognitive skills, which is equal.

Summary

The programme-level features of the DP and VCE are highly aligned, sharing similar approaches in their assessment methods, philosophical underpinnings, entry requirements and programme structure. At subject-level, alignment between the VCE and DP varies across subjects. For mathematics, low alignment was found between the DP mathematics courses, at both SL and HL, and the VCE courses of Foundation Mathematics, General Mathematics, and Further Mathematics, while moderate to high alignment was observed for Mathematics Methods and Specialist Mathematics. VCE physics, chemistry and biology were also found to be moderately to highly aligned with the DP science courses, observing stronger alignment at SL than at HL. Finally, high alignment was found between VCE history and DP history, both at SL and HL.

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 Australian upper-secondary programme of education. As agreed with the IB, since Australia organises its education at the state level, this report focuses specifically on the Victoria upper-secondary programme of education.

[2] International Baccalaureate. (2022). *Diploma Programme*. 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:

Victoria (Australia) Research Questions

Table 1: Victoria (Australia) research questions

RQ1: To what degree does the DP curriculum align with the Victoria 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 regards 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 regards 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 Victoria's (Australia) curriculum

DP subject (group)	Victoria (Australia) 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	Foundation Mathematics (Units 1 and 2) General Mathematics (Units 1 and 2) Further Mathematics (Units 3 and 4) Mathematical Methods (Units 1, 2, 3 and 4) Specialist Mathematics (Units 1, 2, 3 and 4)
mathematics: applications and interpretation SL and HL	
HISTORY	
history SL and HL	history

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

2.3 Report Structure

In responding to the above research questions, 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 Victoria upper secondary curriculum. 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 Victoria 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
- Diploma Programme: From principles into practice
- Programme Standards and Practices
- DP subject guides:
    - mathematics: analysis and approaches
    - mathematics: applications and interpretation
    - biology
    - chemistry
    - physics
    - history

VCE Documentation

- Documentation by the Victorian Curriculum and Assessment authority (VCAA), including information about underpinning philosophy and pedagogy
- The Victoria Curriculum – Secondary Subjects Guides:
    - VCE Mathematics Study Design
    - VCE Physics Study Design
    - VCE Chemistry Study Design
    - VCE Biology Study Design
    - VCE History Design

Philosophical Underpinnings Comparison

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

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

Documentation containing philosophical underpinnings	
DP	**VCE**
'What is an IB Education', particularly the following sections: ○ IB learner profile ○ International-mindedness ○ Approaches to teaching and approaches to learning (ATL).[5]	'Principles and procedures for the development and review of VCE studies', in particular the following section: ○ Curriculum and assessment principles for VCE studies.[6]

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

[6] Victorian Curriculum and Assessment Authority. (2018). *Principles and procedures for the development and review of VCE studies*. https://www.vcaa.vic.edu.au/Documents/vce/Principles_Procedures_VCE_review.docx

While the document 'What is an IB Education?' provides detailed information about the IB's educational philosophy, the philosophy and pedagogy of the VCE are articulated to a lesser extent in the curriculum documentation available. Nevertheless, the 'Curriculum and assessment principles for VCE studies' section of the VCAA's 'Principles and procedures for the development and review of VCE studies' document[7] was deemed to provide sufficient detail for a meaningful comparison between the two programmes' philosophical underpinnings and were used as such.

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

Learning Outcomes Comparison

For the Learning Outcomes comparisons, Ecctis used the following categories of the curriculum documentation for comparison:

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

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 assessment objectives
mathematics: applications and interpretation	
HISTORY	
Victoria (Australia) subjects	**Categories utilised as learning outcomes**
SCIENCES	
biology	Outcomes
chemistry	Outcomes
physics	Outcomes
MATHEMATICS	
Foundation Mathematics (Units 1 and 2)	Aims Outcomes
General Mathematics (Units 1 and 2)	
Further Mathematics (Units 3 and 4)	
Mathematical Methods (Units 1, 2, 3 and 4)	
Specialist Mathematics (Units 1, 2, 3 and 4)	
HISTORY	
history	Aims

Although not all 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.

[7] Ibid.

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 VCE. 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) has alignment with another programme (in this case, the VCE). 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 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 Victoria, it sought to:

- Analyse to what extent the VCE has similarities with the DP.
- Analyse to what extent the VCE lacks features contained within the DP.
- Analyse to what extent the DP lacks features contained within the VCE.

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 VCE, 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 VCE (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

For the DP, the ATL, the learner profile, and the framework of international-mindedness were used to represent the philosophical underpinnings, while the 'Curriculum and assessment principles for VCE studies' section of the VCAA's 'Principles and procedures for the development and review of VCE studies' document[8] was used for the VCE.

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

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

This list of themes was mapped against both the DP's philosophical underpinnings and the philosophical underpinnings of the VCE to identify what aspects of the DP's philosophical underpinnings are shared with the comparison programme and what aspects are unique to either the VCE'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 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. 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-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 VCE.

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 VCE and any knowledge areas and skills found in the VCE but not in DP.

Content

To compare the content of the DP subject and the comparison VCE 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 VCE 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 VCE subject and on VCE 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 study. 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'.

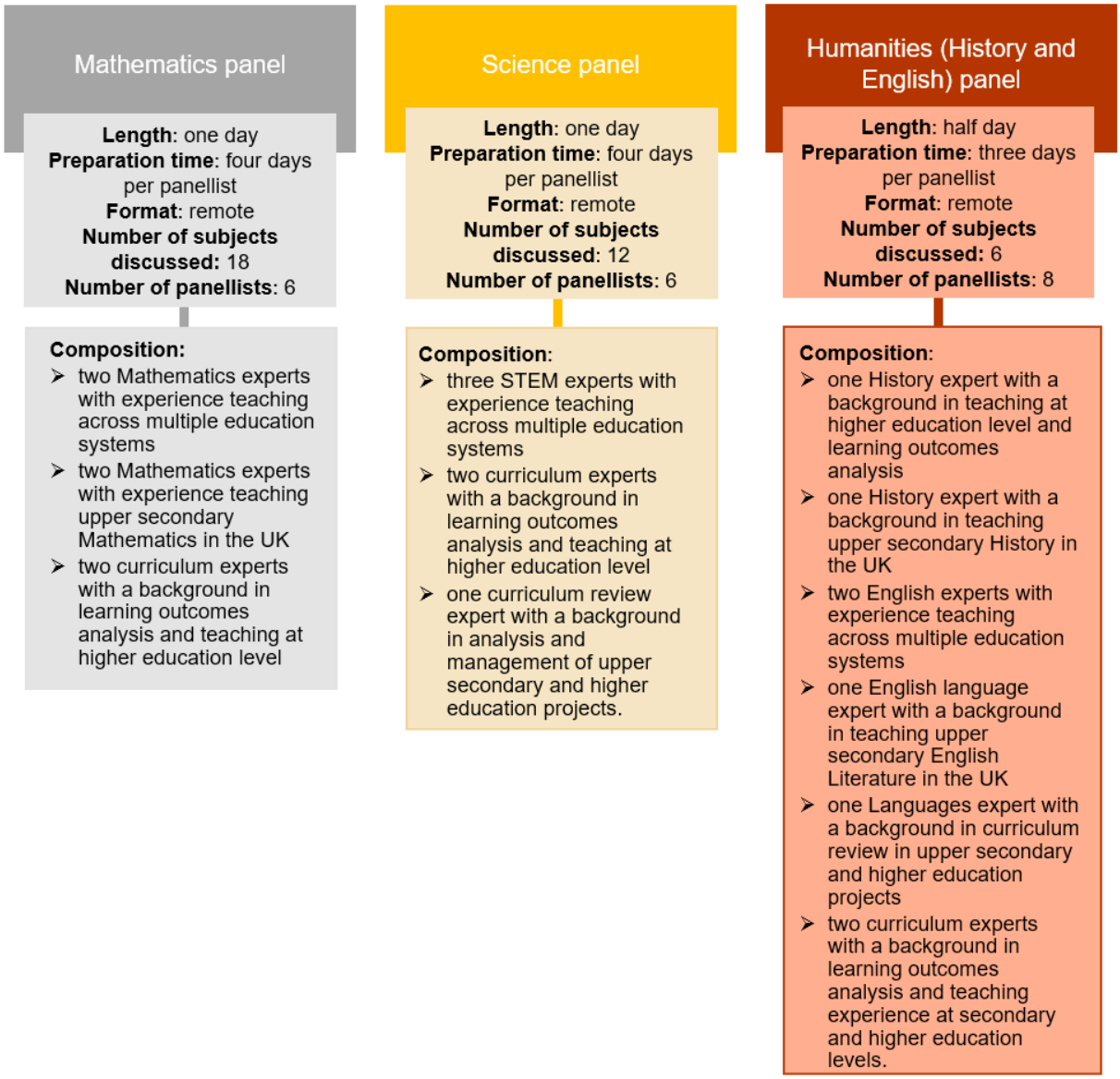
Demand Panel: Expert Judgement Procedure

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 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 CCSS and NGSS, VCE, and OSSD reports, the composition of each panel was as follows:

[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. Microsoft Word - Webb DOK all content.doc (pbworks.com)
[11] Note: 'depth of content' primarily describes what is in 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).
[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. Both the Mathematics and Science demand panels lasted one full working day, while the Humanities (History and English) 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 regards 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 VCE, 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 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 SL or HL. 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*. https://www.ibo.org/programmes/diploma-programme/curriculum/
[16] Ibid.
[17] International Baccalaureate. (2021). *Theory of knowledge*. 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.* 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*.

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 which 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*. https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/; International Baccalaureate. (2014). *International Baccalaureate Diploma Programme: A guide to assessment*. p. 3.
[24] International Baccalaureate. (2021). *Assessment and Exams*. https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/
[25] International Baccalaureate. (2021). *Understanding DP Assessment*.
[26] Ibid.
[27] Iternational 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 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 represents the lowest.[30] Their combined results can contribute up to three additional numerical points to the overall DP score (see Table 7 below). CAS does not constitute a graded part of the DP, although its completion is mandatory to receive the award of 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 DP, 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 Victoria Certificate of Education

Structure

The Victoria Certificate of Education (VCE) is awarded to students who successfully complete years 11 and 12 in the state of Victoria, Australia, providing 'diverse pathways to further study or training at university'.[36] This is typically achieved by successfully completing from 16 to 24 units of study across a number of subjects. Each subject contains four units that last for one semester each and have a minimum scheduled classroom instruction time of 50 hours.[37] For most students, the VCE is completed over a two-year period. Students typically study Units 1 and 2 of each subject in their first year, and Units 3 and 4 in their second year.[38]

The VCE is flexible, meaning that students can take longer than two years to complete studies if needed. Alternatively, the VCE course can also be completed in a shorter or earlier timeframe – some students may opt to start studying the VCE in Year 10, while some may study Units 3 and 4 in Year 11.[39] Additionally, those who are identified as outstanding students may opt to extend their studies by undertaking a university subject within the VCE.[40]

Students have the option to study Unit 1 or Unit 2 of a subject as stand-alone units. However, students must enrol in Units 3 and 4 of the same subjects as a sequence. This sequence needs to be completed in the same year for the study score to be calculated.[41]

There is a large variety of study options in VCE through which students can elect subjects relevant to their goals and interests for progression onto higher education or into the workforce. There are over 90 VCE studies and over 20 VCE Vocational Education and Training (VET) courses for students to select from across the subject groups.[42] It is down to the discretion of the individual institution to decide which VCE studies and VET subjects to offer.

Unit Requirements

To be awarded the VCE, candidates must successfully complete 16 units, including:

- three units from the English group, two of which must be a Unit 3 and 4 sequence.
- at least three additional Unit 3 and 4 sequences.

The various studies offered as part of the course are listed (by subject area) in the table below.

[36] Victorian Curriculum and Assessment Authority. (n.d.). *How VCE Works – The Facts.* https://www.vcaa.vic.edu.au/studentguides/myvce/Pages/HowVCEWorks.aspx
[37] Ibid.
[38] Ibid
[39] Ibid.
[40] Ibid. No definition of what constitutes an 'outstanding student' is provided.
[41] Ibid.
[42] Ibid.

Table 8: Overview of studies in VCE, per subject group[43]

VCE Study Design overview	
Performing Arts	• Dance • Drama • Music • Theatre Studies
Visual Arts	• Art • Media • Studio Arts • Visual Communication Design
VCE Vocational Major	• VCE VM Literacy • VCE VM Numeracy • VCE VM Work Related Skills • VCE VM Personal Development Skills
Technologies	• Agricultural and Horticultural Studies • Food Studies • Product Design and Technology • Systems Engineering
Mathematics	• Foundation Mathematics • General Mathematics • Further Mathematics • Mathematical Methods • Specialist Mathematics
VCE VET Programs	• Agriculture, Horticulture, Conservation and Land Management • Animal Studies • Applied Fashion Design and technology • Applied Language • Automotive • Building and Construction • Business • Cisco • Civil Infrastructure • Community Services • Creative and Digital Media • Dance • Electrical Industry • Engineering • Equine Studies • Furnishing • Hair and Beauty • Health • Hospitality • Information, Digital Media and Technology • Integrated Technologies • Laboratory Skills • Music Industry • Plumbing • Small Business • Sport and Recreation
English	• Bridging English as an Additional Language • English and English as an Additional Language

[43] Victorian Curriculum and Assessment Authority. (2022). *VCE Study Designs*. https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/Pages/vce-study-designs.aspx

VCE Study Design overview	
	• English Language • Foundation English • Literature
Science	• Biology • Chemistry • Environmental Science • Physics • Psychology
Business and Economics	• Accounting • Business Management • Economics • Industry and Enterprise • Legal Studies
Languages	• Languages
Health and Physical Education	• Health and Human Development • Outdoor and Environmental Studies • Physical Education
Humanities	• Australian and Global Politics • Classical Studies • Geography • History • Philosophy • Religion and Society • Sociology • Texts and Traditions
Extended Investigation	• Extended Investigation
Digital Technologies	• Algorithmics (HESS) • Applied Computing

Assessment

The grading systems for the Units are as follows:[44]

- Units 1 & 2: students receive either S (Satisfactory), or N (Non-Satisfactory). Individual education institutions may issue specified grades for each unit, but only the S counts towards your VCE.
- Units 3 & 4: Students receive grades calculated from A+ (high) to E, UG (Ungraded), or NA (Not Assessed) for assessment tasks, as well as an S or N as in Units 1&2.

Units 1 and 2 are assessed and marked internally by each educational institution, with educators designing and setting a range of different assessments to measure academic progression. This includes school-assessed coursework (SAC) completed at school and school-assessed tasks (SAT) completed both at school and at home. Internal assessment is designed around the 'outcomes' described in the curriculum documentation and must offer 'a variety of learning activities and assessment tasks that provide a range of opportunities for students to demonstrate the key knowledge and key skills in the outcomes'.[45] Moreover, despite being designed and conducted internally, the VCAA conducts quality assurance on

[44] Ibid.
[45] Ibid.

internal assessments to ensure that all schools in the state are marking to the same standard.[46]

In contrast, Units 3 and 4 are assessed via three graded assessments per subject, with assessments being both internal (i.e. SACs and SATs) and external. For the comparison subjects in this particular study, the breakdown is as follows:

Table 9: Overview of assessment methods for Units 3 and 4, per comparative subject[47]

Subject	Internal assessment	External assessment
Further Mathematics (Units 3 and 4)	Unit 3: school-assessed coursework, worth 20% Unit 4: school-assessed coursework, worth 14%	Two end-of-year examinations, worth 33% each
Mathematical Methods (Units 3 and 4)	Unit 3: school-assessed coursework, worth 17% Unit 4: school-assessed coursework, worth 17%	Two end-of-year examinations, worth 22% (end of Unit 3) and 44% (end of Unit 4)
Specialist Mathematics (Units 3 and 4)	Unit 3: school-assessed coursework, worth 17% Unit 4: school-assessed coursework, worth 17%	Two end-of-year examinations, worth 22% (end of Unit 3) and 44% (end of Unit 4)
Physics	Unit 3: school-assessed coursework, worth 21% Unit 4: school-assessed coursework, worth 19%	End of year examination, worth 60%
Chemistry (Units 3 and 4)	Unit 3: school-assessed coursework, worth 16% Unit 4: school-assessed coursework, worth 24%	End of year examination, worth 60%
Biology	Unit 3: school-assessed coursework, worth 20% Unit 4: school-assessed coursework, worth 30%	End of year examination, worth 50%
History	Unit 3: school-assessed coursework, worth 25% Unit 4: school-assessed coursework, worth 25%	End of year examination, worth 50%

For VCE VET courses, these are assessed through two graded assessments, which may be School-based Assessments and/or external assessments depending on the subject.[48]

Overall, if students complete at least two graded assessments and achieve an S for both Units 3 and 4 in a subject in the same year, they will be issued a study score. A study score is a number between 0 and 50 that indicates the candidates ranking comparative to all students completing the same subject study in the same academic year.[49]

[46] Victorian Curriculum and Assessment Authority. (n.d.). *How VCE Works – The Facts.*
[47] Victorian Curriculum and Assessment Authority. (2022). *VCE Study Designs*.
[48] Victorian Curriculum and Assessment Authority. (n.d.). *How VCE Works – The Facts.*
[49] Ibid.

External assessments are set and marked by the VCAA. They are the same for all students taking the same VCE study. Typically, this will be an examination – whether written, oral, performance or in an electronic format.[50]

General Achievement Test (GAT):

The GAT assesses a student's general knowledge, written communication skills, and proficiency in mathematics, science, technology, humanities, the arts and social sciences. The GAT also assesses a student's literacy and numeracy skills against a new standard based on the skills typically expected of someone completing secondary schooling, introduced in 2022.[51] *'While the GAT is important, it does not directly count towards a student's final VCE results. GAT results are used to check that VCE external assessments and school-based assessments have been accurately and fairly assessed. GAT results may also play a part in determining the final score for a VCE external assessment if a student has a derived examination score approved for that assessment*'.[52]

No official preparatory work is required for candidates undertaking the GAT, as the GAT seeks to measure the students' competency as a result of their other studies. '*All students studying at least one Unit 3 & 4 VCE subject (including a VCE VM Unit 3 and 4 subject) or a scored VCE VET subject are expected to sit all or a section of the General Achievement Test (GAT)'.*[53]

VCE Vocational Major

The VCE Vocational Major (VM) is a recent development to the VCE, described as a vocational and applied learning programme within the VCE. The VCE VM is regarded as an alternative route to develop students' skills in preparation for enrolment into apprenticeships, traineeships, further education and training or university through alternative entry programmes or directly into the workforce.[54]

VCE VM Structure:

The VCE VM is comprised of subjects designed to prepare students for a vocational pathway.[55] They are:

- VCE VM Literacy
- VCE VM Numeracy
- VCE VM Work Related Skills
- VCE VM Personal Development Skills (and 180 nominal hours of VET at Certificate II level or above).

Each subject is composed of four units, which are each based on a set of specified learning outcomes assessed by teachers through a range of learning supervised activities and tasks, including community-based activities and projects that involve working collaboratively. Candidates must successfully finish a minimum of 16 units,[56] including:

[50] Ibid.
[51] Ibid.
[52] Ibid.
[53] Ibid.
[54] Ibid.
[55] Ibid.
[56] Ibid.

- 3 VCE VM Literacy or VCE English units (including a Unit 3–4 sequence)
- 2 VCE VM Numeracy or VCE Mathematics units
- 2 VCE VM Work Related Skills units
- 2 VCE VM Personal Development Skills units, and
- 2 VET credits at Certificate II level or above (180 nominal hours).

Most students study between 16-20 units over the courses' two-year duration. Students must complete a minimum of three other Unit 3 & 4 subjects, and they may opt to study other VCE subjects to count towards the VM. Students may also receive structured workplace learning recognition where, unlike other VCE subjects, there are no external assessments, apart from the General Achievement Test (GAT). Therefore, candidates do not have study scores or an Australian Tertiary Admission Rank (ATAR).[57]

Curriculum Design Principles

The main curriculum design principles for the VCE are articulated in the 'Curriculum and assessment principles for VCE studies' of the VCAA's 'Principles and procedures for the development and review of VCE studies' document.[58] In these, it becomes apparent that the VCE prioritises the development of students who are able to transition into further education and the workforce by adopting an inclusive and community-oriented outlook that reflects democratic values. To do so, the course prioritises the following principles:

Table 10: Principles and procedures for the development and review of VCE studies.[59]

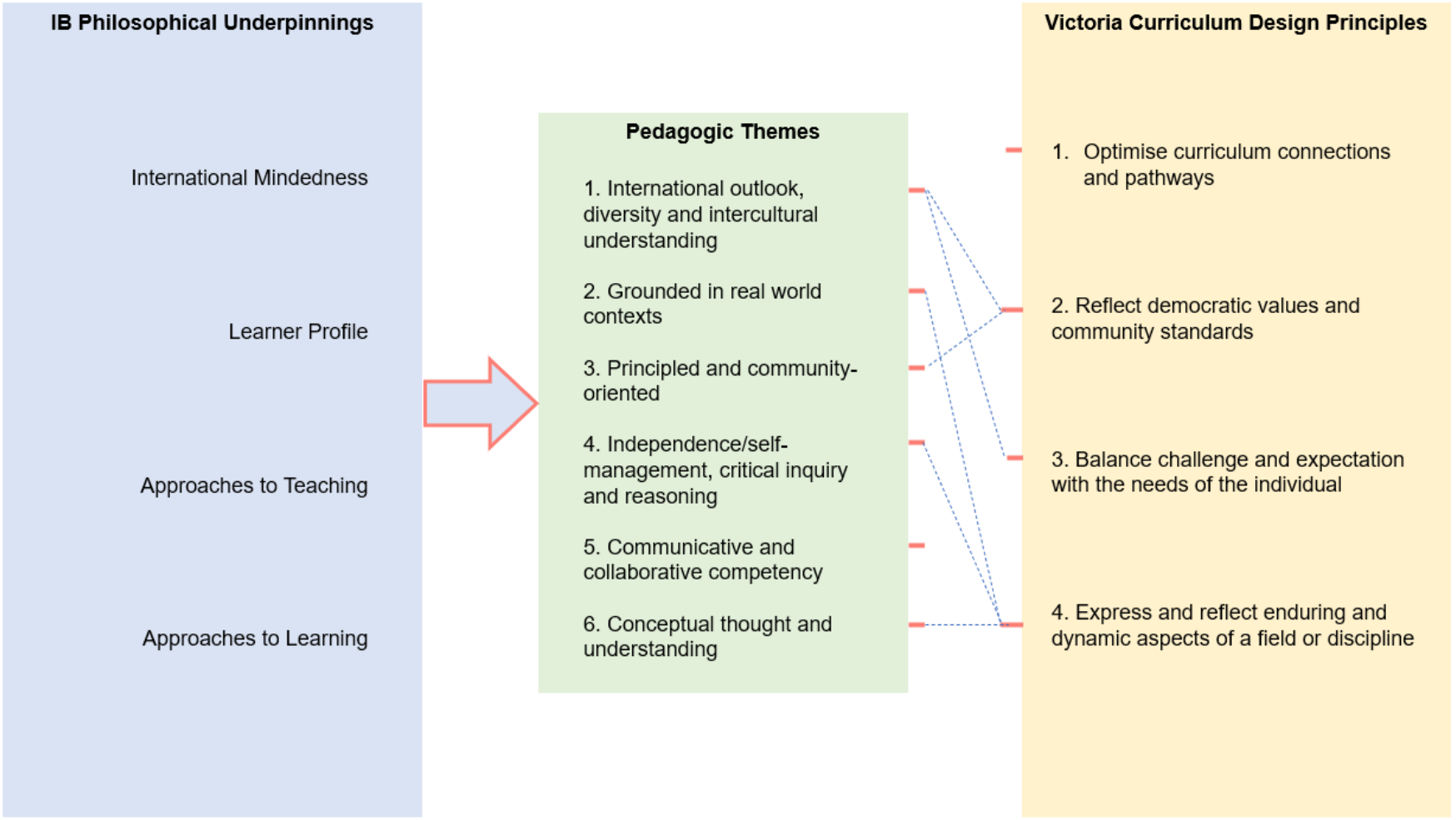
Principles and procedures for the development and review of VCE studies	
Optimisation of curriculum connections and pathways	• VCE studies will have clear connections with and build on the knowledge, skills and understandings developed over the compulsory years of schooling, as reflected in the Victorian Curriculum F–10. • VCE studies support students in making the transition to further education, training or the workforce.
Reflection of democratic values and community standards	• VCE studies will be consistent with social values, community standards, government policies and legislation. The curriculum is free from discrimination on the basis of gender, culture, physical disability, socioeconomic background or geographic location. The curriculum will provide access to indigenous content where relevant.
Balance of challenge and expectation with the needs of the individual	• VCE studies cater for students with a wide range of ability levels, providing appropriate levels of differentiation, setting high but reasonable expectations, and allowing students to develop and achieve their best.

[57] Ibid.
[58] Victorian Curriculum and Assessment Authority. (2018). *Principles and procedures for the development and review of VCE studies*.
[59] Ibid.

Principles and procedures for the development and review of VCE studies	
	Standards will be established by comparison to other like studies and to leading national and global jurisdictions.
Expression and reflection of enduring and dynamic aspects of a field or discipline	• VCE studies will draw on valued disciplines and knowledge domains to assist students to develop contemporary understandings and skills. VCE studies will do this by: 1. Identifying specific knowledge, skills and understanding to be demonstrated by students. 2. Drawing on contemporary contexts and examining future challenges. 3. Requiring higher order thinking, critical perspectives and analysis. 4. Promoting investigation of the nature of inquiry associated with the disciplines underpinning the study.

4.2 Philosophical Underpinnings

Figure 3: Philosophical underpinnings comparative analysis diagram for the DP and VCE



The IB learner profile, which is used across all IB programmes including the DP, outlines ten attributes that all students should strive towards.[60] 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 VCE, the project team mapped the philosophical underpinnings of the VCE against six themes extracted from the DP's philosophical underpinnings.

Table 11: 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 VCE curriculum design principles, the main difference identified was the lack of presence of the DP's 'Communicative and collaborative competency' theme in Victoria's curriculum design principles, with the latter making no reference to communication competency. In addition, none of the DP's themes were deemed to explicitly encompass the 'optimise curriculum connections and pathways' principle found in the Victoria curriculum, though reference to helping 'students make connections and transfer learning to new contexts' is made within the approaches to teaching.[61]

All other themes, such as 'International outlook, diversity and intercultural understanding', 'Independence/self-management, critical inquiry and reasoning', 'Principled and community-oriented', 'Grounded in real world contexts', and 'Conceptual thought and understanding' – were found to be explicitly present and comprehensively covered in Victoria's curriculum design principles. As such, the level of philosophical and pedagogical alignment observed between the DP and the VCE was found to be considerable.

[60] International Baccalaureate. (2017). *What is an IB education?*
[61] Ibid.

4.3 Structure

There are six subject groups comprising the DP and students pursuing the Diploma award are required to select one subject from each of the six groups.[62] The DP also has three 'core' components which are compulsory and are carried out alongside subjects. The VCE also organises its subjects in subject categories, though it features 14 different categories (as opposed to three). In order to get their VCE, students must successfully complete 16 units, including: three units from the English group, two of which must be a Unit 3 and 4 sequence; at least three additional Unit 3 and 4 sequences.

The figures below present the subject groups of the DP in comparison with the subjects that cover similar areas of learning in the VCE.

Figure 4: Structural overview of the DP

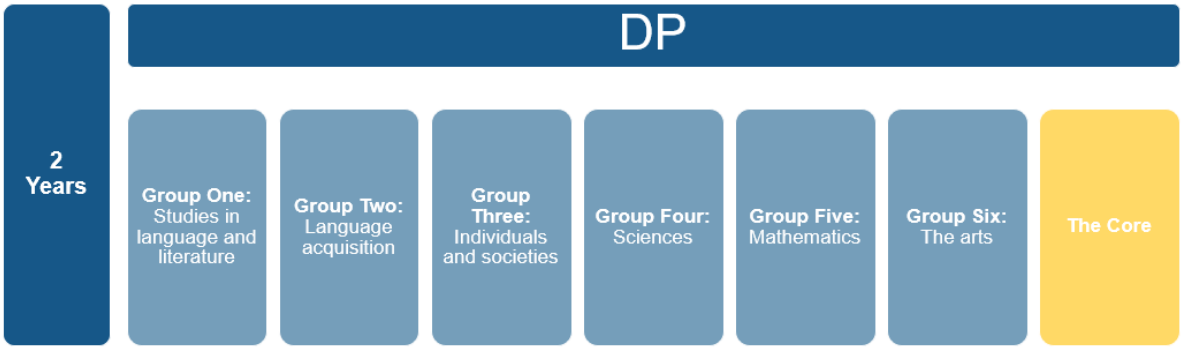
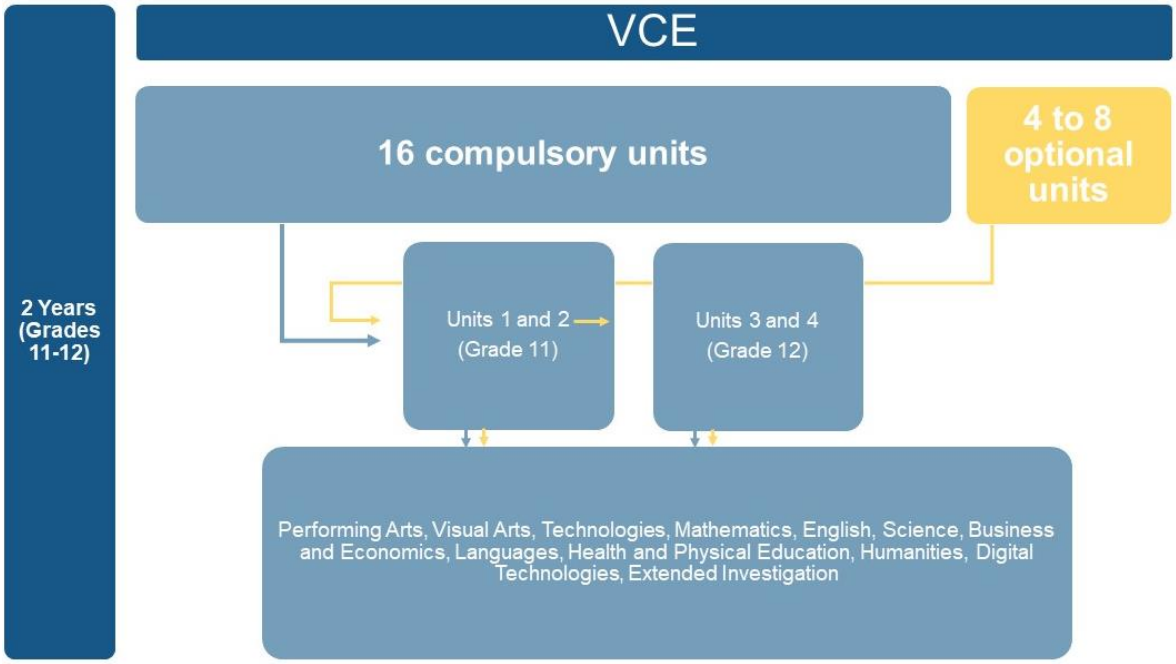


Figure 5: Structural overview of the VCE



[62] International Baccalaureate. (2021). *How the Diploma Programme works*. https://www.ibo.org/programmes/diploma-programme/what-is-the-dp/how-the-diploma-programme-works/

As shown in the diagrams above, both the DP and the VCE cover similar subject areas. Both programmes cover subjects including languages, science, mathematics, social sciences and humanities (including history, geography, politics, philosophy, religion studies), business studies, economics, technologies, performing and visual arts. Additionally, both programmes include a research project – named the extended essay in the DP and extended investigation in the VCE.

One key difference between the two programmes is that the VCE offers students the opportunity to follow an alternative route through the VCE Vocational Major which includes four subjects designed to prepare students for a vocational pathway, offering a variety of VCE VET programmes outlined in the table above. This option is not offered in the DP, but a vocational pathway is possible in some IB World Schools through the Career-related Programme (IB CP).

The DP includes CAS which is a mandatory curriculum component focusing on students' involvement in community activities. A similar subject is not available in the VCE. However, one of the VCE VET programmes is on community services, though this course is only available to students who choose the vocational route.

Additionally, in the DP students can study the six chosen disciplines concurrently, with the subjects being offered at two levels: HL and SL. This differentiation in terms of level of difficulty within the same course is not offered in the VCE.

4.4 Requirements and Associated Outcomes

Regarding duration, both the DP and the VCE are two-year programmes of study. However, in contrast with the DP, the VCE duration is flexible, meaning that students can take longer than two years to complete their studies if needed.

In terms of entry requirements, there are no formal entrance requirements stipulated for the DP as the IB envisages numerous educational pathways leading to upper secondary education.[58] However, the IB recommends consulting the subject guides prior to enrolment to ensure an adequate understanding of programme expectations.[59] Similarly to the DP, there are no formal entrance requirements for the VCE and students may enter studies at the level of Units 1, 2 or 3. In some studies, students are advised to complete either or both Units 1 and 2 before attempting Unit 3, or have equivalent experience, or be willing to undertake some preparatory learning.

Regarding associated outcomes, both the DP and the VCE aim to prepare students for higher education and/or the workplace.

4.5 Student Learning Pathways

In terms of learning pathways, both programmes include compulsory and optional subjects. 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 6: DP imagined pathway for a student wishing to study physics at university

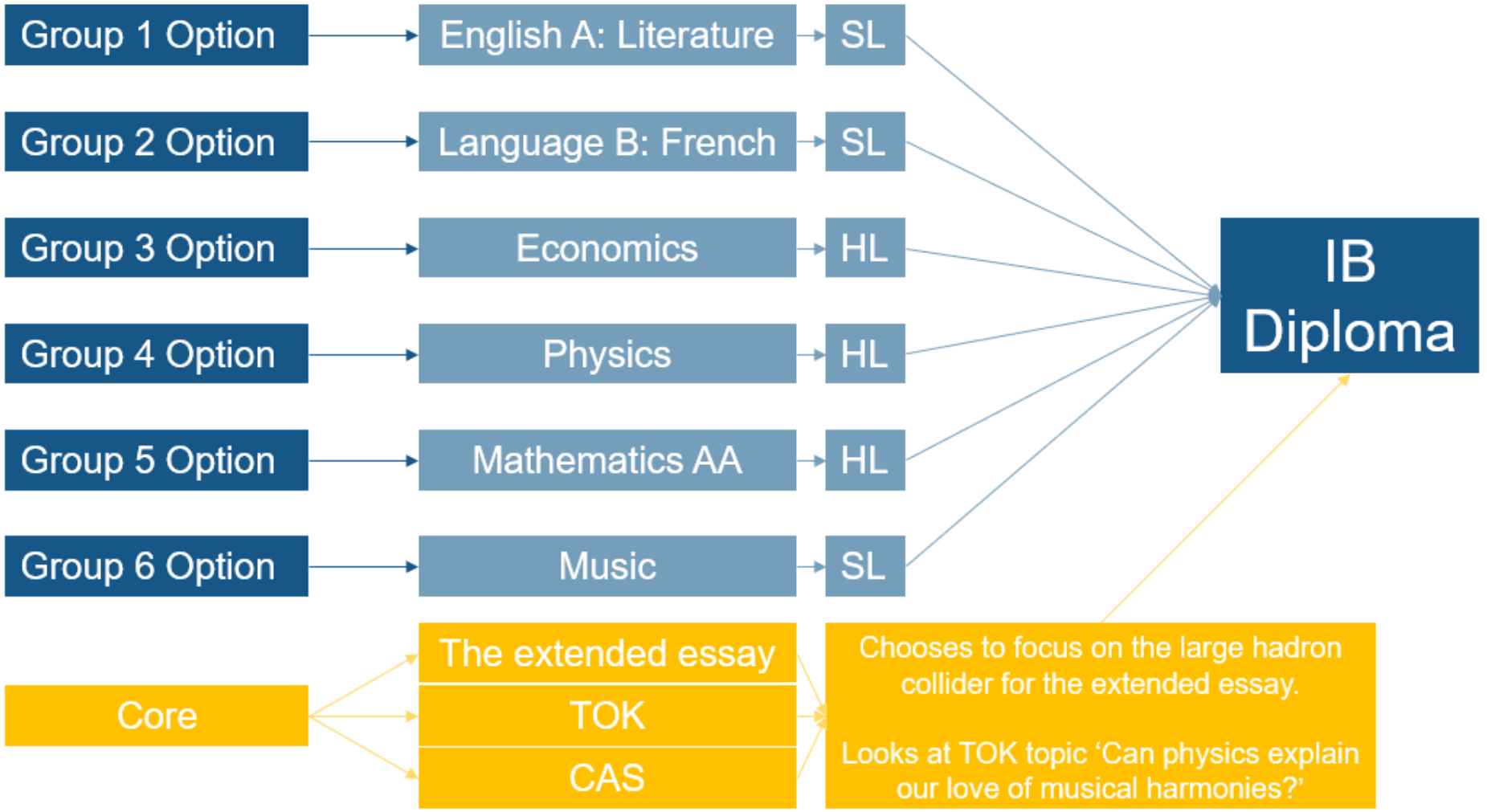
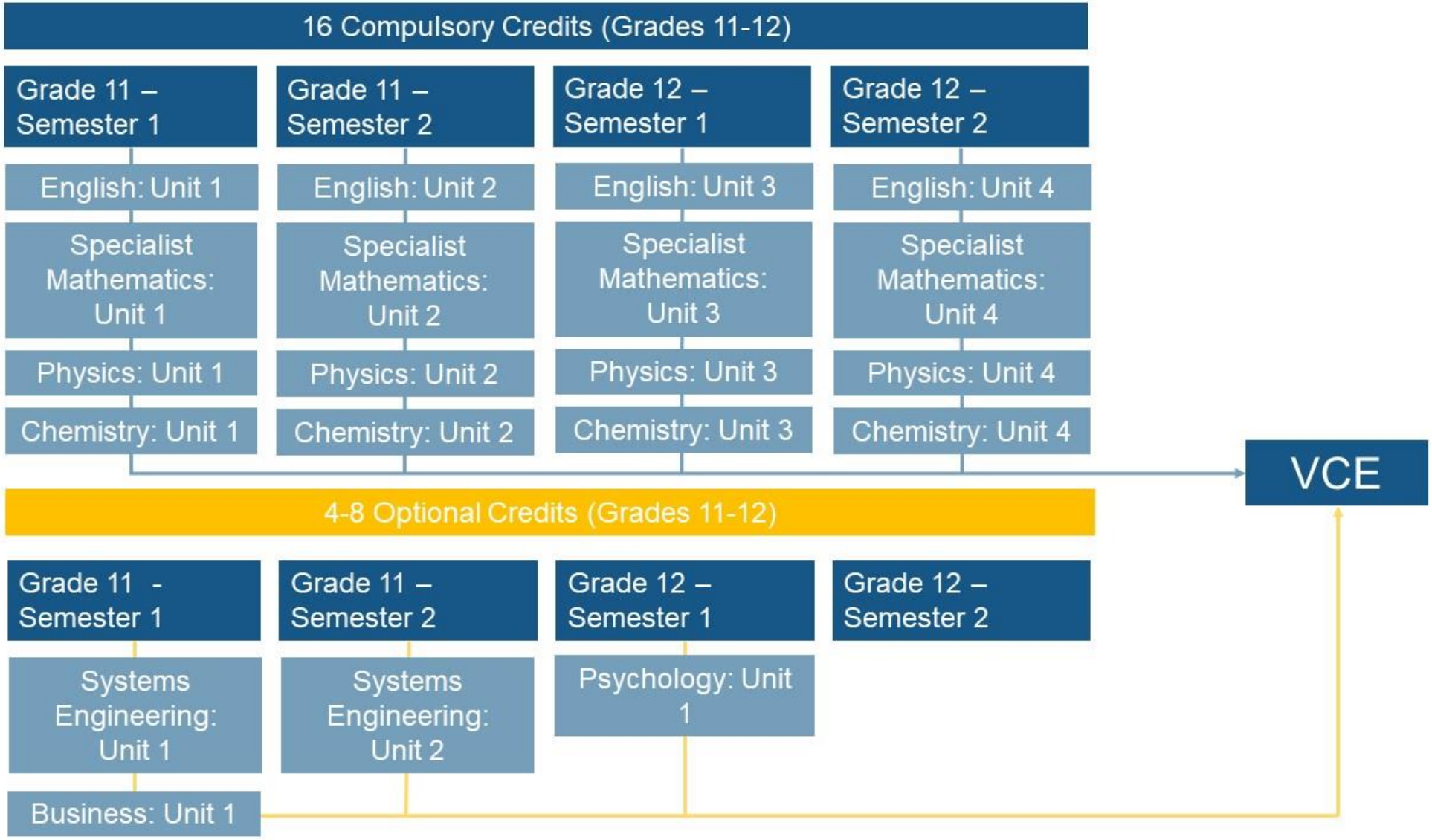


Figure 7: VCE imagined pathway for a student wishing to study physics at university



In the DP, learners are required to study six subjects concurrently, typically one from each subject group.[60] Students may opt to study a second subject from groups one to five instead of selecting an arts-based subject from group six. To receive the IB Diploma it is compulsory to take at least three of the subjects at higher level, with the remaining disciplines studied at standard level.[61] Up to four subjects can be taken at higher level.

The VCE also offers a large variety of study options through which students can elect subjects relevant to their goals and interests for progression onto higher education or into the world of work. There are over 90 VCE studies and over 20 VCE VET programs for students to select from across the subject groups. It is down to the discretion of the individual institution to decide which VCE studies it will offer. However, in contrast with the DP, the selection of subjects is flexible – apart from the mandatory requirement to study at least three units from the English group, students are free to choose their other subjects regardless of the subject group they belong to. As a result, the VCE offers further opportunity for specialisation – e.g. a student can theoretically choose to study four science subjects if they wish to do so (see diagram above for an example).

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.[63]

[63] In the Canada (Ontario) report of this study series, an additional table has been included at the end of the Assessment section which compares the assessment objectives of the DP subjects with those of Ontario subjects (i.e. the comparison subjects). Due to the way the VCE assessment is structured, it is not possible to include the same table for the VCE, so a qualitative write-up has been included instead.

Table 12: Comparison of the assessment methods per subject between the DP and the VCE

	DP	VCE
External assessment	✓	✓
Weighting	Varies by subject	Varies by subject
Mathematics	**SL & HL**: 80%	**Further Mathematics (Units 3 and 4):** Two end-of-year examinations, worth 33% each **Mathematical Methods (Units 3 and 4):** Two end-of-year examinations, worth 22% (end of Unit 3) and 44% (end of Unit 4) **Specialist Mathematics (Units 3 and 4):** Two end-of-year examinations, worth 22% (end of Unit 3) and 44% (end of Unit 4)
Sciences	**SL & HL**: 80%	**Physics (Units 3 and 4):** End of year examination, worth 60% **Chemistry (Units 3 and 4):** End of year examination, worth 60% **Biology (Units 3 and 4):** End of year examination, worth 50%
History	**SL:** 75% **HL:** 80%	**Units 3 and 4:** End of year examination, worth 50%
Methods	Exam (typically, two-three exam papers per subject)	Exam (typically, one to two end-of-year examinations per subject)
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.	Weighting and format vary for different units. Question types include multiple-choice, short response and extended answer.
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.	Terminal examination paper worth 50% for biology and 60% for physics and for chemistry. Information not available on question types or duration.
History	**SL**: 2 papers worth 30% and 45% of total weighting, with duration of 60 and 90 minutes each. **HL**: 3 papers worth 20%, 25%, and 35% of total weighting, with duration of 60, 90, and 150 minutes each.	2-hour examination paper worth 50% of total grade. Information not available on question types.

	DP	VCE
	Question Types: source-based, structured questions; essay questions..	
Internal assessment	✓ (often used)	✓ (used in all subjects)
Weighting	Varies by subject	Varies by subject
Mathematics	**SL & HL**: 20%	**Further Mathematics (Units 3 and 4):** Unit 3: 20% Unit 4: 14% **Mathematical Methods (Units 3 and 4):** Unit 3: 17% Unit 4: 17% **Specialist Mathematics (Units 3 and 4):** Unit 3: 17% Unit 4: 17%
Sciences	**SL & HL**: 20%	**Physics:** Unit 3: 21% Unit 4: 19% **Chemistry (Units 3 and 4):** Unit 3: 16% Unit 4: 24% **Biology:** Unit 3: 20% Unit 4: 30%
History	**SL:** 25% **HL:** 20%	Unit 3: 25% Unit 4: 25%
Methods	Vary by subject, but should follow IB guidance	Vary by subject but options presented in subject guides.
Mathematics	**SL & HL**: A 'mathematical exploration' involving a piece of written work for 20 marks.	Varies by unit, including options such as modelling and problem-solving tasks (2-3 hours duration over 1 week) and application tasks (working with data for 4-6 hours over 1-2 weeks).
Sciences	A practical, individual investigation with 10 hours duration and 6-12 pages of write-up.	**Physics and Chemistry:** Multiple choices from options including reports, reflective learning journals, short tests, etc. Approximately 50 minutes in duration each and not exceeding 1000 words. **Biology:** Multiple choices from the following options (50-75 minutes for a written response, 10 minutes for presentation): • analysis and evaluation of a selected biological case study

	DP	VCE
		• analysis and evaluation of generated primary and/or collated secondary data • comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities • analysis and evaluation of a contemporary bioethical issue Also, a scientific poster based on a student-designed investigation.
History	A 20-hour historical investigation on a topic of the students' choosing. Resulting in 2,200-word essay.	A historical inquiry, an evaluation of historical sources, extended responses, an essay.

Both the DP and the VCE use a combination of internal, school-based assessments as well as external assessments and examinations depending on the subject. In both programmes internal assessments are marked by the teachers but they are externally moderated. More specifically, internal assessments in the DP are moderated by the IB,[64] while in the VCE marks are reviewed by the VCAA, which ensures consistency across Victoria schools' marking standards.[65] Additionally, the internal assessment of both the DP and the VCE includes internally assessed tasks, which are named School-Assessed Tasks (SAT) in the VCE, as well as coursework that it is completed, which is named School-Based Coursework (SAC) in the VCE. In both programmes, the internal assessment tasks and the coursework are completed either during the schooling hours or through independent home learning. In the DP, internally assessed tasks normally comprise between 20-30% of the total examined material per subject.[66] Some of the internal assessment methods used in the DP include: oral work in languages, fieldwork in geography, laboratory work in the sciences, and artistic performances.[67] VCE internal assessment tasks also vary from subject-to-subject and often from unit-to-unit. Overall, many of the types of internal assessment used have alignment with the project and question types used in the DP subjects.

Regarding external assessments, both programmes include an element of external assessments and examinations. In both the DP and the VCE, external assessments are marked externally to the educational institution. In the case of the DP, external assessments are marked by IB examiners and in the case of VCE external examinations are set and marked by the VCAA. Furthermore, in both programmes, external assessment can take a variety of forms, including written, oral, performance or in an electronic format in the VCE.[68] Essays, structured problems, short-response questions, data-response questions, case-study questions, and multiple-choice questions are some of the external assessment question types in the DP.[69]

[64] Ibid.
[65] Ibid.
[66] International Baccalaureate. (2021). *Understanding DP assessment*; International Baccalaureate. (2014). *Diploma Programme: A guide to assessment*. p. 3.
[67] International Baccalaureate. (2021). *Assessment and Exams*.
[68] Ibid.
[69] Ibid.

5. Subject-Level Alignment

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

Table 13: Research question 3

RQ3: To what degree do the subjects align with regards 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, it briefly introduces the subjects being compared, followed by an overview of the findings from the comparative analysis between the DP subjects and the 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[70]
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[71]
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.

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

Foundation Mathematics Units 1 and 2[72]
VCE offers Foundation Mathematics (FM), which is comprised of Units 1 and 2 – to be studied in the first year. FM is aimed at students who do not intend to study mathematics in the second year to obtain a Unit 3 and 4 sequence. However, if supplementary learning is undertaken, students may be able to progress on to Further Mathematics Units 3 and 4.

General Mathematics Units 1 and 2[73]
VCE offers General Mathematics (GM), which is comprised of Units 1 and 2 – to be studied in the first year. GM offers a range of topics which can be chosen to suit students' interests and provide preparation for a range of Unit 3 and 4 sequences. Depending on the topics chosen, GM may complement and support learning in Mathematical Methods and Specialist Mathematics, however, if these units are taken alone then students would only be able to progress onto Further Mathematics Units 3 and 4.

Further Mathematics Units 3 and 4[74]
VCE offers Further Mathematics (FRM), which is comprised of Units 3 and 4 – to be studied in the second year. These units assume knowledge from GM (though can also be accessed with Mathematical Methods) and are designed to provide general preparation for employment or further study - in particular where data analysis, recursion and number patterns are important.

Mathematical Methods Units 1, 2, 3, and 4[75]
VCE offers Mathematical Methods (MM), which is comprised of Units 1 and 2 – to be studied in the first year – and Units 3 and 4 – to be studied in the second year. MM Units 1 and 2 are designed as preparation for Units 3 and 4 and altogether prepare students for further studies in areas such as science, humanities, economics, and medicine. Taking MM also enables students to study Specialist Mathematics.

Specialist Mathematics Units 1, 2, 3, and 4[76]
VCE offers Specialist Mathematics (SM), which is comprised of Units 1 and 2 – available to be taken in the first year – and Units 3 and 4 – to be studied in the second year. SM Units 3 and 4 should be taken in conjunction with MM Units 3 and 4. The areas of study extend concepts learnt in MM and introduce additional advanced topics. Taking Units 3 and 4 also assumes knowledge of MM Units 1 and 2 and the prescribed topics of SM Units 1 and 2. Taking these units prepares students for further study in areas with an advanced mathematical component, such as mathematics or physics.

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

[72] Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Mathematics Study Design.*
[73] Ibid.
[74] Ibid.
[75] Ibid.
[76] Ibid.

for AA and AI. The VCE's mathematics learning outcomes are represented by three broad aims, as well as unit-specific outcomes in each area of study of a course. The unit-specific outcomes include details of the key knowledge and key skills students should gain in that unit, which are necessary for the achievement of each outcome 1, 2, and 3. Though there is some repetition in the outcomes and key skills between units, often they vary and sometimes they are unique to the unit. Therefore both were reviewed for each unit to determine the presence of DP's themes in the VCE.

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

Table 14: Presence of the DP mathematics subject group learning outcome themes in the VCE mathematics curriculum

Themes extracted from the learning outcomes in the DP mathematics subject group	Presence in the VCE	
1. Being aware of, and engaging with, mathematics in its wider context		Mostly not present in the aims or outcomes.
2. Developing learning skills; having a positive and resilient attitude, working both independently and collaboratively, being reflective and evaluating work		Not present in the aims or outcomes
3. Using inquiry-based approaches		Present in the aims and outcomes which describe analysing and investigation. However, in unit-specific outcomes, Foundation Mathematics demonstrates this theme the least.
4. Understanding the concepts, principles and nature of mathematics and applying concepts and procedures to a range of contexts		Present in the aims which state that the study will develop mathematical concepts, knowledge, and skills, as well as the ability to apply mathematics in a range of contexts
5. Making links and generalisations		Weakly present. Some evidence of linking to everyday life in Foundation Mathematics and some evidence of generalisation in Specialist Mathematics.
6. Developing critical/creative thinking skills e.g. problem-solving and reasoning		Present in the aims describing contexts requiring modelling, problem-solving, analysing, and investigation. Evidence of reasoning is only weakly present in some units (Mathematical Methods and Specialist Mathematics).
7. Communicating mathematics clearly and in various forms		Not present in the aims but present in some unit-specific outcomes

8. Knowing how technology and mathematics influence each other and using technology to develop ideas and solve problems		Present in the aims and unit outcomes, technology to be used as a tool for working mathematically.

Key:

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

Presence of the DP's Learning Outcome Themes

The three overall aims of the Mathematics Study Design are short in detail but do offer some insight into the key outcomes for VCE mathematics. Similarly to the DP, the aims state that the study will develop mathematical concepts, knowledge, and skills, as well as the ability to apply mathematics in a range of contexts. Furthermore, both critical thinking and inquiry approach themes are present, as the aims describe contexts requiring modelling, problem-solving, analysing, and investigation. As the third aim, technology is similarly a theme in VCE mathematics outcomes and is to be used as a tool for working mathematically. No other DP themes are present in the aims (communication, learning skills, wider context, or making links), thus they do not present the same holistic development as the DP.

There are no significant themes present in the VCE aims which are not present in the DP. However, it can perhaps be noted that specific critical-thinking skills/processes, such as performing analysis and modelling, are referred to more frequently and have more of a presence in the outcomes than in the DP. This is true for all VCE subjects, except Foundation Mathematics which contained minimal evidence of modelling and analysis.

The outcomes in the units below provide more detail about the skills to be developed and will also be reviewed for their presence of DP themes.

Foundation Mathematics Units 1 and 2

There is some presence of the DP's learning outcome themes in FM, though few are strongly evidenced, and others are absent. Similarly to the DP, FM outcomes describe the need for students to be able to successfully communicate maths in various forms by requiring students to produce tables, graphs and diagrams (with and without technology), and also to be able to interpret, represent and discuss mathematics in different contexts. Furthermore, FM outcomes have a similar focus on technology, as students are expected to be able to perform calculations, produce representations, perform analysis, and solve problems using technological tools. However, at this level, the outcomes do not include the use of technology to develop mathematical ideas, hence this investigative aspect that the DP involves is not included. Indeed, taking an inquiry-based approach is generally not a present theme in these units, as no outcomes or skills require students to conduct investigations, make conjectures, test conclusions or to explore abstract scenarios. Similarly to the DP, FM outcomes include the development of critical thinking skills and processes through requiring students to perform some analysis and solve problems. However, use of reasoning, including inferring and constructing arguments, is not specified clearly in FM outcomes and skills, thus this area does not appear to have the same focus as the DP. Furthermore, there is only limited evidence of links to other disciplines (Pythagoras and art) and no evidence with regards to making

generalisations or engaging with mathematics in its wider context (beyond links to everyday life and some real-life applications). Finally, there is no development of learning skills such as the ability to work both collaboratively and independently, reflect, or to develop a positive and curious attitude towards mathematics studies.

General Mathematics Units 1 and 2

There is some presence of the DP's learning outcome themes in GM, though not all are strongly evidenced, and others are not present at all. Similar to the DP, GM expects students to develop critical thinking skills through problem-solving and modelling in a variety of contexts, although at this level these contexts are described as practical rather than 'non-routine' or 'abstract'. Furthermore, inquiry-based approaches are somewhat present as the skills detail that students should be able to conduct investigations in a variety of contexts and use technology to develop mathematical ideas. Additionally, technology is also a key theme in GM, as students must use it in a variety of ways similar to the DP, including to produce results, problem solve, and understand how mathematics and technology differ. Further themes/skills are present in GM but are only referred to within the context of some specific content. For example, the use of reasoning is only explicitly mentioned with regards to describing a problem-solving process and skills involving communication refer mostly to modelling and statistical representations. Furthermore, making links to other disciplines is restricted to technology. Hence, unlike the DP, these skills/themes are not clearly intended to be developed throughout all the topics within the unit. Finally, in contrast to the DP, GM does not include outcomes or skills which are aimed at student awareness and engagement with maths in its wider context or the development of learning skills such as reflection, collaboration, independence, and positive disposition.

Further Mathematics Units 3 and 4

Some of the DP's themes are present in the outcomes and skills of FRM. Similarly to the DP, FRM includes outcomes and skills directed at the development of critical thinking skills, such as being able to solve extended problems, analyse information, and use modelling. Furthermore, the outcomes expect students to be able to communicate in various forms such as through producing representations (with and without technology), interpretation of information, and reports of investigations. Also similar is their technology-focused outcomes and skills which describe that students will be able to use technology in a variety of ways, specifically to develop ideas and carry out analysis for problem-solving and investigations. The outcomes for these units also require students to be able to investigate a range of problems and scenarios, with and without technology, thus this is comparable to the DP's theme of expecting students to be able to take an inquiry-based approach. However, despite these similarities, there are DP themes which are not present in the units. FRM outcomes do not include being aware of, or engaging with, maths in its wider context, such as exploring different global and local issues or perspectives or critically questioning the implications of mathematics. Also, the units do not focus on developing learning skills such as the ability to collaborate, work independently, reflect, or to build curiosity and confidence. Furthermore, reasoning is not a general skill to be developed over the unit but is only mentioned in the context of describing the process taken to problem-solve in technology. Finally, a theme not present is the development of students' powers of abstraction and generalisation and the ability to make links to other disciplines beyond technology.

Mathematical Methods Units 1, 2, 3 and 4

The DP's learning outcome themes are somewhat present in the outcomes of MM. Looking at the outcomes and key skills, it is evident that students are similarly expected to develop critical thinking skills and processes through problem-solving, modelling, analysing, inferring, and reasoning. At this level, it is expected that the students work with familiar, unfamiliar, and non-routine contexts. Furthermore, students need to be able to use technology to calculate, produce graphs/tables, analyse, problem-solve and develop ideas, as well as understand the similarities and differences of technology and mathematics. Communication of mathematics is also a present theme in these units, as key skills describe the production of tables, graphs, diagrams, and also the communication of reasoning and conclusions using words and mathematical expressions. There is also evidence of students being expected to have the skills to work using an investigative approach, as the outcomes and key skills describe students being able to use mathematical processes in scenarios requiring investigative techniques and approaches. However, some of DP's themes are not present or are only somewhat present. Not present is the DP's theme of students being aware of, and engaging with, mathematics in its wider context, as these units do not include any key skills or outcomes related to questioning the implications of mathematics or looking at global and historical perspectives. Furthermore, there is no focus on students making links to other disciplines or everyday life and local contexts. Another theme not present is the development of learning skills, such as the ability to work collaboratively, reflect on work, be resilient, or to have curiosity and enthusiasm. Finally, there is only limited evidence of skills aimed at the development of abstraction and generalisation skills, as these are only present where the content requires them – rather than being skills to be continuously developed in all topics.

Specialist Mathematics Units 1, 2, 3 and 4

The DP's learning outcome themes are somewhat present in SM. A theme which is strongly evidenced is that of using critical thinking skills through problem-solving, use of reasoning, inferring conclusions, and applying analysis when problem solving, taking investigation approaches or modelling. There is also evidence of students being expected to have the skills to work using an inquiry approach, as the outcomes and key skills describe students being able to use mathematical processes in scenarios requiring investigative techniques and approaches. In addition, the key skills clearly demonstrate that students are required to be able to communicate by producing representations (tables, graphs, diagrams), conclusions using mathematical and everyday language, and through using technology. Furthermore, as can be seen in the other outcomes, technology is a key area of focus, indeed it is one of the three main outcomes described. In SM, students are expected to use technology to perform calculations, produce graphics, develop mathematical ideas, perform analysis, and understand how mathematics and technology relate to one another and the differences that are produced. Finally, from the learning outcomes and skills there is some evidence that students are expected to use abstraction and generalisation, although these are mostly linked to content where these skills are necessary, rather than being skills which are to be used throughout the whole unit. There is also some limited evidence of students making links through drawing upon various areas of knowledge for an investigation, however there is no expectation that students make links to other disciplines. In contrast to the DP, SM contains no outcomes or skills which are aimed at developing students' awareness and engagement with mathematics in a wider context or developing transferable learning skills such as resilience, collaboration, independence, and reflection.

Summary
The VCE's learning outcomes are structured differently to the DP, as they include specific outcomes for each mathematics course, whereas the DP has the same set of outcomes for all its mathematics subjects. There are some overlaps in the learning outcomes of the DP and VCE mathematics subjects. The strongest similarities found are with the themes of understanding mathematical concepts, applying critical thinking skills in analysis and problem-solving, using investigative skills, and the emphasis on the use of technology. However, not all extracted DP themes are present, as VCE mathematics outcomes do not focus on wider contexts of mathematics or transferable learning skills. Furthermore, DP themes which are present in the VCE are often not emphasised or described in similar ways to the DP. Generally lacking in emphasis is reasoning, using generalisation, making links, and communicating in various forms. Though references to these skills are made, they are often very specific in nature, rather than being presented as general expectations to be continually developed. Overall, SM is the most aligned with DP outcomes as it includes more focus on reasoning and making generalisations, closely followed by MM. In contrast, FM learning outcomes are the least aligned to the DP.

5.1.2 Content – Mathematics

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

Figure 8: 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 logs; 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 9: 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 10: VCE Units 1 and 2 mathematics content visualiser

Foundation Mathematics Units 1 and 2	**Area of Study 1: Space, shape and design**	Overview: In this area of study students cover the geometric properties of lines and curves, and shapes and objects, and their graphical and diagrammatic representations with attention to scale and drawing conventions used in domestic, societal, industrial and commercial plans, maps and diagrams.		
	Area of Study 2: Patterns and number	Overview: In this area of study students cover estimation, the use and application of different forms of numbers and calculations, and the representation of patterns and generalisations in number including formulas and other algebraic expressions in everyday contexts.		
	Area of Study 3: Data	Overview: In this area of study students cover collection, presentation and analysis of gathered and provided data from community, work, recreation and media contexts, including consideration of suitable forms of representation and summaries.		
	Area of Study 4: Measurement	Overview: In this area of study students cover the use and application of the metric system and related measurement in a variety of domestic, societal, industrial and commercial contexts, including consideration of accuracy.		
General Mathematics Units 1 and 2	**Area of Study 1: Algebra and structure**	Linear relations and equations		
	Area of Study 2: Arithmetic and number	Computation and practical arithmetic	Financial arithmetic	
	Area of Study 3: Discrete mathematics	Matrices	Graphs and networks	Number patterns and recursion
	Area of Study 4: Geometry, measurement, and trigonometry	Shape and measurement	Applications of trigonometry	
	Area of Study 5: Graphs of linear and non-linear relations	Linear graphs and models	Inequalities and linear programming	Variation
	Area of Study 6: Statistics	Investigating and comparing data distributions	Investigating relationships between two numerical variables	
Mathematical Methods Unit 1	**Area of Study 1: Functions and graphs**	In this area of study students cover the graphical representation of simple algebraic functions (polynomial and power functions) of a single real variable and the key features of functions and their graphs such as axis intercepts, domain (including the concept of maximal, natural or implied domain), co-domain and range, stationary points, asymptotic behaviour and symmetry. The behaviour of functions and their graphs is explored in a variety of modelling contexts and theoretical investigations.		
	Area of Study 2: Algebra	This area of study supports students' work in the 'Functions and graphs', 'Calculus' and 'Probability and statistics' areas of study, and content is to be distributed between Units 1 and 2. In Unit 1 the focus is on the algebra of polynomial functions of low degree and transformations of the plane.		
	Area of Study 3: Calculus	In this area of study students cover constant and average rates of change and an introduction to instantaneous rate of change of a function in familiar contexts, including graphical and numerical approaches to estimating and approximating these rates of change.		
	Area of Study 4: Probability and statistics	In this area of study students cover the concepts of event, frequency, probability and representation of finite sample spaces and events using various forms such as lists, grids, venn diagrams, karnaugh maps, tables		

		and tree diagrams. This includes consideration of impossible, certain, complementary, mutually exclusive, conditional and independent events involving one, two or three events (as applicable), including rules for computation of probabilities for compound events.	
Mathematical Methods Unit 2	**Area of Study 1: Functions and graphs**	In this area of study students cover graphical representation of functions of a single real variable and the key features of graphs of functions such as axis intercepts, domain (including maximal, natural or implied domain), co-domain and range, asymptotic behaviour, periodicity and symmetry.	
	Area of Study 2: Algebra	This area of study supports students' work in the 'Functions and graphs', 'Calculus' and 'Probability and statistics' areas of study. In Unit 2 the focus is on the algebra of some simple transcendental functions and transformations of the plane. This area of study provides an opportunity for the revision, further development and application of content prescribed in Unit 1, as well as the study of additional algebra material introduced in the other areas of study in Unit 2	
	Area of Study 3: Calculus	In this area of study students cover first principles approach to differentiation, differentiation and anti-differentiation of polynomial functions and power functions by rule, and related applications including the analysis of graphs.	
	Area of Study 4: Probability and statistics	In this area of study students cover introductory counting principles and techniques and their application to probability and the law of total probability in the case of two events.	
Specialist Mathematics Units 1 and 2	**Area of Study 1: Algebra and structure**	Logic and algebra	Transformations, trigonometry, and matrices
	Area of Study 2: Arithmetic and number	Number systems and recursion	Principles of counting
	Area of Study 3: Discrete mathematics	Graph theory	
	Area of Study 4: Geometry, measurement, and trigonometry	Geometry in the plane and proof	Vectors in the plane
	Area of Study 5: Graphs of linear and non-linear relations	Graphs of non-linear relations	Kinematics
	Area of Study 6: Statistics	Simulation, sampling and sampling distributions	

Figure 11: VCE Units 3 and 4 mathematics content visualiser

Further Mathematics Units 3 and 4	**Area of Study 1: Unit 3 – Core**	Data analysis	Recursion and financial modelling		
	Areas of Study 2: Unit 4 – Applications	Matrices	Networks and decision mathematics	Geometry and measurement	Graphs and relations
Mathematical Methods Units 3 and 4	**Area of Study 1: Functions and graphs**	In this area of study students cover transformations of the plane and the behaviour of some elementary functions of a single real variable, including key features of their graphs such as axis intercepts, stationary points, points of inflection, domain (including maximal, implied or natural domain), co-domain and range, asymptotic behaviour and symmetry. The behaviour of these functions and their graphs is to be linked to applications in practical situations.			
	Area of Study 2: Algebra	In this area of study students cover the algebra of functions, including composition of functions, simple functional relations, inverse functions and the solution of equations. They also study the identification of appropriate solution processes for solving equations, and systems of simultaneous equations, presented in various forms. Students also cover recognition of equations and systems of equations that are solvable using inverse operations or factorisation, and the use of graphical and numerical approaches for problems involving equations where exact value solutions are not required, or which are not solvable by other methods. This content is to be incorporated as applicable to the other areas of study			
	Area of Study 3: Calculus	In this area of study students cover graphical treatment of limits, continuity and differentiability of functions of a single real variable, and differentiation, anti-differentiation and integration of these functions. This material is to be linked to applications in practical situations.			
	Area of Study 4: Probability and statistics	In this area of study students cover discrete and continuous random variables, their representation using tables, probability functions (specified by rule and defining parameters as appropriate); the calculation and interpretation of central measures and measures of spread; and statistical inference for sample proportions.			
Specialist Mathematics Units 3 and 4	**Area of Study 1: Functions and graphs**	In this area of study students cover inverse circular functions, reciprocal functions, rational functions and other simple quotient functions, the absolute value function, graphical representation of these functions, and the analysis of key features of their graphs including intercepts, asymptotic behaviour and the nature and location of stationary points, points of inflection, periodicity, and symmetry			
	Area of Study 2: Algebra	In this area of study students cover the expression of simple rational functions as a sum of partial fractions; the arithmetic and algebra of complex numbers, including polar form; points and curves in the complex plane; introduction to factorisation of polynomial functions over the complex field; and an informal treatment of the fundamental theorem of algebra.			
	Area of Study 3: Calculus	In this area of study students cover advanced calculus techniques for analytic and numeric differentiation and integration of a range of functions, and combinations of functions; and their application in a variety of theoretical and practical situations, including curve sketching, evaluation of arc length, area and volume, differential equations and kinematics.			
	Area of Study 4: Vectors	In this area of study students cover the arithmetic and algebra of vectors, linear dependence and independence of a set of vectors, proof of geometric results using vectors, vector representation of curves in the plane and vector kinematics in one and two dimensions			
	Area of Study 5: Mechanics	In this area of study students cover an introduction to Newtonian mechanics, for both constant and variable acceleration			
	Area of Study 6: Statistics and probability	In this area of study students cover statistical inference related to the definition and distribution of sample means, simulations and confidence interval.			

Structure

Similarly to the DP, VCE mathematics is designed to span two years and offers different options for mathematics study. However, differently to the DP, the VCE structures its programme and content into yearly units. Like the DP, VCE mathematics offers an option for those wanting to study mathematics at a more advanced level, which is that of SM. Just as additional higher level (AHL) content cannot be studied without SL in DP mathematics subjects, SM is designed to be studied along with MM in Units 3 and 4 and expects students to have taken MM Units 1 and 2 and have relevant knowledge from SM Units 1 and 2. However, where the DP offers two HL options that each take a different focus (AA and AI), SM does not take a specific focus but combines elements of both pure and applied mathematics. Furthermore, content in the VCE units caters for a greater range of mathematical abilities by also offering courses at the lower end, such as FM. In addition to course options based on level, like the DP, VCE also offers courses which consider the relevant skills needed for future studies/careers, as SM and MM offer more opportunities to explore 'pure' mathematics and FRM dedicates more time to explore applications in statistics and finance. However, where AA and AI have a large amount of overlapping content, the difference between some VCE 'pure-focused' and 'applied-focused' units' content is more pronounced – for instance, FRM and MM share very little content.

Like the DP, content within units is structured into main themes – areas of study – which are then broken down into smaller sections detailing what is to be studied in each area. However, where the DP's main topics remain the same regardless of the subject and level, VCE's main themes and content structure vary greatly between units. See below for more detail on each subject's content structure.

Foundation Mathematics Units 1 and 2

FM content is structured into main themes of 'Space, shape and design', 'Patterns and number', 'Data', and 'Measurement'. Thus, FM offers fewer main themes than the DP, which covers 'Number and algebra', 'Functions', 'Geometry and trigonometry', 'Statistics and probability', and 'Calculus' – five themes in total. Furthermore, the main topics named differ significantly to those in the DP, hence demonstrating that FM covers different material to the DP subjects.

General Mathematics Units 1 and 2

Differently to the DP, GM is structured into six, rather than five, main themes. These are 'Algebra and structure', 'Arithmetic and number', 'Discrete mathematics', 'Geometry, measurement, and trigonometry', 'Graphs of linear and non-linear relations', and 'Statistics'. However, unlike the DP, not all these main themes are studied by students taking the course. The Areas of Study are broken down into topics, all of which are optional. Students must take at least eight (out of 13) topics, from at least three Areas of Study. Thus, this offers an element of flexibility not offered in AA and AI subjects.

Further Mathematics Units 3 and 4

These units differ significantly in content structure to other units and the DP. Unit 3 has one Area of Study, 'Core', which has two large, non-optional topics: 'Data analysis' and 'Recursion and financial modelling'. In Unit 4, the Area of Study is 'Applications', where two topics must be chosen from 'Matrices', 'Networks and decision mathematics', 'Geometry and measurement', and 'Graphs and relations'. Thus, FRM has an element of flexibility not present

in DP mathematics subjects. Moreover, FRM covers a much smaller range of mathematical areas than AA and AI and tends to focus on applied mathematics, hence this subject is most different to AA.

Mathematics Methods Units 1, 2, 3 and 4
In these units, content is structured into fewer main themes than the DP mathematics subjects. These include: 'Functions and graphs', 'Algebra', 'Calculus', and 'Probability and statistics'. These themes are very similar to those of the DP – with the exception of 'Geometry and trigonometry' content being integrated into other themes rather than being stand-alone themes themselves. Overall, this demonstrates that the MM covers similar content areas to those covered in the AA and AI.

Specialist Mathematics 1, 2, 3 and 4
Units 1 and 2 are structured differently to Units 3 and 4. Areas of Study in Units 1 and 2 are 'Arithmetic and number', 'Geometry, measurement and trigonometry', 'Graphs of linear and non-linear relations', 'Algebra and structure', 'Discrete mathematics', and 'Statistics'. However, unlike the DP subjects, these units contain both 'prescribed' topics and optional topics. Prescribed topics are 'Number systems and recursion', 'Geometry in the plane and proof', 'Vectors in the plane', and 'Graphs of non-linear relations'. As well as these, at least four topics must be chosen from either GM or the following list: 'Logic and algebra', 'Transformations, trigonometry and matrices', 'Principles of counting', 'Graph theory', 'Kinematics', and 'Simulation, sampling, and sampling distributions'. Thus, the structure of content in SM Units 1 and 2 allows for more flexibility than DP mathematics subjects. For Units 3 and 4, all content must be covered, which includes 'Functions and graphs', 'Algebra', 'Calculus', 'Vectors', 'Mechanics', and 'Probability and statistics'. Altogether, SM units include more main themes than AA and AI.

Content Alignment
To complement the analysis, the figures below represent a simplified summary of the VCE's content alignment, at topic-level, with AA (SL and HL) and AI (SL and HL).

Figure 12: Summary of the content alignment VCE subjects have with the main topics in AA

Mathematics: analysis and approaches topics		Presence in VCE				
		Foundation Mathematics	General Mathematics	Further Mathematics	Mathematical Methods	Specialist Mathematics
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					
	4. Statistics and probability					
	5. Calculus					

Figure 13: Summary of the content alignment VCE subjects have with the main topics in AI

Mathematics: applications and interpretation topics		Presence in VCE				
		Foundation Mathematics	General Mathematics	Further Mathematics	Mathematical Methods	Specialist Mathematics
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					
	4. Statistics and probability					
	5. Calculus					

Key:

	Strong presence of this topic in the VCE		*Partial presence of this topic in the VCE*		*Little or no presence of this topic in the VCE*

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

Foundation Mathematics Units 1 and 2

All DP mathematics subjects

FM contains very minimal content alignment with the content in both AA and AI. Most of the topics and sub-topics in FM would be covered by, or be at the same level of, the prior-learning topics of the DP. There are a couple of partial alignments with introductory sub-topics in

'Geometry and trigonometry' and 'Statistics and probability' – for both AA and AI – and 'Number and algebra' – AI only, though these are due to overlaps with prior-learning content (such as finding measures of central tendency). Therefore, FM content does not align with the DP mathematics content, as it covers material more congruent with mathematic studies prior to upper secondary.

General Mathematics Units 1 and 2

Mathematics: analysis and approaches

GM contains small amounts of AA content in all topics apart from 'Calculus'. The mapping of content shows that alignment is only found with a small number of the SL sub-topics AA shares with AI, hence no AA-specific content was covered, including AHL. Furthermore, some topic areas of GM, such as Area of Study 1 Algebra and Structure, are more aligned with content that would be expected to be covered in learning prior to the DP. Where found, alignments tend to be partial, due to either containing less of the content in the sub-topic, or for taking a different approach. The topic GM has the most sub-topic alignments with (four) is 'Number and algebra', due to GM containing sequences and applications – though they somewhat differed by focusing on recursion. The topic which GM has the most strongly aligned sub-topics with is 'Statistics and probability', as GM includes sub-topics of presenting data, measures of central tendency and dispersion, and correlation and linear regression.

However, many sub-topics and larger topics are not covered. Some significant SL areas not included in GM are calculus, probability, laws of exponents and logarithms, quadratics and other functions, and trigonometric equations and identities. However, it can be noted that GM contains some significant sub-topics which are not included in AA content, which are found in Area of Study 3 'Discrete mathematics' and Area of Study 5 'Graphs of linear and non-linear relations'. 'Discrete mathematics' covers topics such as matrices – (including matrix algebra and solving systems of equations) and 'Graphs and networks' (including minimum spanning trees and Prim's Algorithm). Furthermore, Area of Study 5 includes a sub-topic of inequalities and linear programming. However, it is important to reinstate that all topics are optional and therefore these topics may not be studied by some students taking GM.

In summary, GM content has weak to no alignment with SL, no alignment with AHL content and observes smaller content breadth than AA SL and AA HL.

Mathematics: applications and interpretation

GM contains some AI content, though very little in certain topics and none from 'Calculus'. The mapping of the content shows that GM has some alignments in the sub-topic areas present at the start of each topic, common to both AA and AI. However, unlike AA, further alignments beyond these are found when comparing GM content and AI content, with additional ones in the topics of 'Number and algebra', 'Functions', and 'Geometry and trigonometry'. Specifically, these alignments come from GM's inclusion of matrices, decision mathematics, and modelling in its content. Matrices in GM are covered to the same depth as in AI, though are not extended to eigenvectors and eigenvalues. Modelling skills are covered to a similar extent to AI, though GM mostly focuses on linear models and linear regression. Likewise, GM has good alignment with AI's decision mathematics sub-topics, though GM only considers Prim's Algorithm and no others. The only significant sub-topic covered by GM and not AI is that of linear programming.

In summary, there is weak to no alignment with AI's SL content in most topics, and only occasional sub-topic alignment with AHL content in 'Number and algebra' and 'Geometry and trigonometry'. Overall, GM observes smaller content breadth than AI SL and AI HL.

Table 15: General Mathematics content which is not covered by DP mathematics subjects

Significant GM content not in AA (only)*	Significant GM content not in AI (only)*
○ Matrices** ○ Graphs and networks** ○ Variation** ○ Linear models (including piecewise)**	
Significant content not in either DP mathematics subject*	
○ Linear programming**	

*Significant content does not include topics which are typical to mathematical learning prior to upper secondary
** Optional content

Further Mathematics Units 3 and 4

The analysis of alignment below considers General Mathematics (GM) and Further Mathematics (FRM) together, as this is a typical combination of units.

Mathematics: analysis and approaches
FRM Units 3 and 4 content is mostly not aligned with AA, for both SL and HL. No AA AHL sub-topics are found to be present in FRM, nor any alignments from the topic of 'Calculus'. There are a few alignments with SL sub-topics within the other main topics. However, FRM largely contains content that is not focused on in AA. Unit 3 covers 'Core' topics to be taken by all studying FRM, which focuses on two key areas of 'Data analysis' and 'Recursion and financial modelling'. Within these are topics which are not covered by AA, such as a focus on modelling, performing residual analysis, data transformations, modelling with time series data, annuities and perpetuities, and balancing repayment loans. Thus, FRM content goes deeper into some areas of statistics and finance than AA. Furthermore, the optional topics in Unit 4 include other areas not covered by AA such as matrices, networks and decision mathematics, spherical geometry, and linear programming. Overall, FRM Units 3 and 4 are weakly aligned with AA SL content and have no alignment with AHL content – they generally focus on areas of applied mathematics and have far less content breadth.

Mathematics: applications and interpretation
FRM has slightly more alignments with AI content than AA, due to its similar focus on applications. However, FRM does not have enough sub-topic alignments with SL or AHL to conclude good alignment with either level. FRM has 4-7 sub-topic alignments in all main AI topics, except for 'Calculus', including occasional AHL sub-topics. AHL sub-topics alignments are matrices, graph theory, decision maths, and transition matrices – with also some elements of analysing the appropriateness of a model (linear models only). Significant alignments with SL content include financial applications, such as compound interest, amortization and annuities, and modelling skills. Though many AI topics are not included in FRM, there are a few areas not covered by AI which are in FRM. These include, data transformations, modelling

time series data, spherical geometry, linear programming, and greater depth in financial applications. Overall, FRM is not closely aligned with either AI SL or AHL content but does involve some of the similar areas in statistics, finance, and decision maths. In terms of subject breadth, FRM is considerably narrower than AI SL and HL, especially considering that only two Unit 4 topics are studied.

Table 16: Further Mathematics content which is not covered by DP mathematics subjects

Significant FRM content not in AA (only)	Significant FRM content not in AI (only)
• Amortization and annuities • Residual analysis and use of the coefficient of determination • Matrices* • Transition matrices* • Graph theory and decision mathematics* • Linear models* (including piecewise)	
Significant content not in either DP mathematics subject **	
• Modelling time series data • Data transformation • Recursion and further depth into financial applications • Linear programming* • Spherical geometry*	

*Optional content

**Significant content does not include topics which are typical to mathematical learning prior to upper secondary

Mathematical Methods 1, 2, 3 and 4

Mathematics: analysis and approaches

A considerable amount of AA SL content is present in MM units, however most AHL content is not present. The mapping of content shows that MM has the most sub-topic alignments with 'Functions', with SL content being well-covered, along with a small amount of AHL. Though the content does not extend to most of AHL, MM differs to the scope of AA by also requiring modelling with the functions. SL 'Calculus' content is also strongly present in MM, with only the sub-topic of the second derivate being notably absent. Though most AHL content is not covered, MM does go into some depth by similarly including concepts of continuity and differentiability, evaluation of limits, and finding derivatives of some polynomials using a first principles approach.

Furthermore, most SL 'Geometry and trigonometry' content is present in MM, though AHL sub-topics are not covered, as MM does not extend to reciprocal trigonometric functions, include double angle identities, or (most significantly) cover any content related to vectors, which accounts for a considerable proportion of this topic. For 'Statistics and probability', MM covers some sub-topics relating to probability and discrete/continuous random variables, but a considerable number of sub-topics are not present. However, the lack of content alignment is partially a result of MM focusing on different areas such as sampling and population proportions. MM has the least alignment with 'Number and algebra', as a considerable amount

of SL sub-topics are not included, nor are significant AHL areas of proof and complex numbers.

In summary, MM has strong alignment with AA SL content in 'Functions', 'Calculus', and 'Geometry and trigonometry', good alignment with 'Statistics and probability', and some alignment with 'Number and algebra'. Additionally, a few alignments with AHL content are found in all topics, though these were mostly in small sub-topics rather than large areas. Thus, content in MM units can be considered to have similar breadth and depth of AA SL, but not AA HL.

Mathematics: applications and interpretation

A considerable amount of AI SL content is present in MM units, however most significant AHL sub-topics are not included. The mapping of content shows that 'Functions' content is strongly present, as MM has alignment with most SL sub-topics and is partially aligned with AHL content, with no large areas excluded. Furthermore, 'Calculus' SL content is also strongly present and, though most AHL content is not covered, MM has some elements of depth by including concepts of continuity and differentiability, evaluation of limits, and finding derivatives using a first principles approach.

For 'Geometry and trigonometry', MM has alignment with less than half of the sub-topics (which are a mixture of SL and AHL). Significant areas not present in MM content are Voronoi diagrams and AHL content such as vectors, graph theory, and decision maths. Similarly, a considerable amount of 'Number and algebra' is not present, such as sequences, financial applications, matrices, and complex numbers. With regards to 'Statistics and probability', MM covers some sub-topics relating to probability, binomial and normal distributions, and discrete and continuous random variables, but a considerable number of sub-topics (mostly AHL and some SL) are not present.

In summary, for AI SL content, MM is strongly aligned with the topics of 'Functions' and 'Calculus', partially aligned with 'Statistics and probability' and 'Geometry and trigonometry', and not aligned with 'Number and algebra'. For AHL content, MM has some alignment with 'Functions', and a couple of sub-topic alignments with other topics. If MM is taken with GM, SL content would be largely covered in all topics, as would AHL content involving matrices and decision mathematics. However, this is not to say that MM content breadth and depth is less than AI SL, as it contained some areas not in AI (see table below). However, it can be noted that the breadth and depth of MM is considerably less than that of AI HL.

Table 17: Mathematical Methods content which is not covered by DP mathematics subjects

Significant MM content not in AA (only)	Significant MM content not in AI (only)
○ Modelling functions and skills ○ Matrix transformations ○ Definition and distribution of sample proportions, simulations, and confidence intervals	○ Binomial theorem ○ Counting principles ○ Solving inequalities ○ Analytical solutions ○ Polynomial functions, factor theorem ○ Solving trigonometric equations analytically ○ Symmetry properties

	○ Continuous random variable probability density functions ○ Limits and first principles of differentiation
Significant content not in either DP mathematics subject *	
N/A	

*Significant content does not include topics which are typical to mathematical learning prior to upper secondary

Specialist Mathematics Units 1, 2, 3, and 4

For students completing SM Units 3 and 4, it is assumed that they will have at the very least, studied all MM units and the topics of 'Number systems and recursion' and 'Geometry in the plane and proof' found in Specialist Maths Units 1 and 2.

Mathematics: analysis and approaches
Considering SM Units 3 and 4 with the assumed prior knowledge first, the content mapping shows that this content altogether strongly aligns with AA SL and AHL content. Nearly every sub-topic in 'Number and algebra', 'Functions', and 'Calculus' is present and most of the significant areas in the other main topics are covered either entirely or partially. Lesser alignment with 'Geometry and trigonometry' is due to differences in the AHL area of vectors, where similar content is covered, though SM then focuses on vector calculus rather than equations of planes and the vector product. There is good alignment with 'Statistics and probability' – the only significant area not covered being correlation and regression, which is instead covered in GM. As well as being strongly aligned with AA content, SM Units 3 and 4 include topics which are not covered by AA. These include a topic of 'Mechanics' and some different coverage of statistics (including some hypothesis testing).

Further to this minimum assumed knowledge, it is important to note that most of the students taking SM Units 3 and 4 will have taken Units 1 and 2 in their entirety (not just the assumed knowledge). The inclusion of all SM Units 1 and 2 content does not have much impact on alignment, as most content relevant to AA is covered again and in greater depth in SM Units 3 and 4 – with the exception of sequences and counting principles. However, SM Units 1 and 2 offer further topics that are not present in AA. These include graph theory, a stand-alone topic of kinematics, more matrices, cartesian, polar and parametric forms, and graphs of lines, parabolas, circles, ellipses, and hyperbolas. However, it is important to note that some of these are optional content, thus not all may be studied.

Alternatively, in order to take SM Units 3 and 4, students can instead take GM with MM (though relevant knowledge from SM Units 1 and 2 is still assumed). In this case, the content from this combination of units brings further alignment with 'Statistics and probability' (for correlation and linear regression) and content beyond the scope of AA is graph theory and matrices – though these are optional topics.

In summary, SM Units 3 and 4 and the content assumed to have been learnt prior has strong alignment with AA SL and HL content. Where SM Units 1 and 2 or GM Units 1 and 2 are also taken, there is opportunity for further topics which are not included in AA to be covered.

Therefore, students taking SM are likely to cover greater content breadth than AA SL and HL. The depth of content in SM is comparable to AA HL.

Mathematics: applications and interpretation

The mapping of content shows that SM Units 3 and 4 – along with MM units and the assumed knowledge from SM Units 1 and 2 – is well-aligned with AI SL and AHL content for most topics and strongly aligned in two topics. SM is most strongly aligned with the topics of 'Functions' and 'Calculus', with nearly all SL and AHL sub-topics being present, though it can be noted that phase portraits are not covered.

SM is well-aligned with 'Number and algebra', however two significant areas are not covered in SM, which are eigenvalues and eigenvectors and sub-topics related to finance, such as interest and annuities. Furthermore, there is good alignment with 'Geometry and trigonometry' as AHL sub-topics such as vectors, radians, and trigonometric identities are included. SM would be further aligned with AHL if students take the topic of 'Graph Theory' in SM Units 1 and 2, which would satisfy two further AHL sub-topics. Though, regardless of this, the sub-topics of Voronoi diagrams and adjacency matrices would not be covered. The topic that SM has the least alignment with is 'Statistics and probability', as SM only covers hypothesis testing for a sample mean and does not include several significant areas such as chi-squared tests, linear and non-linear regression, the Poisson distribution, or transition matrices.

In the case where students take GM with, or instead of SM Units 1 and 2, this could bring more alignments with certain sub-topics, such as with financial applications, handling data and linear regression, graph theory, and decision maths.

Though SM units lack some areas of alignments with AI, especially in AHL 'Statistics and probability' content, they cover numerous other topics which are beyond the scope of AI. Some of these are in AA, such as proof, reciprocal trigonometric ratios and further identities, the absolute value function, probability density functions, and implicit differentiation (see table below for list). Further to these are also 'Mechanics' in SM Units 3 and 4, and (if taken) some of the additional topics in SM Units 1 and 2 such as counting principles, algebra and logic, kinematics as a stand-alone topic, and cartesian, polar and parametric forms and graphs.

In summary, SM has strong alignment with content in AI SL and HL. Alignment is somewhat affected by choice of optional content in SM Units 1 and 2 or GM. However, overall, there is good alignment with SL and HL content in all topics – except 'Statistics and probability' which is partially aligned. Furthermore, though not all SL and AHL AI sub-topics are covered, SM instead covers content found in AA or neither DP subject. If all SM and MM units are taken, then the content breadth is more than AI HL, though not with regards to the area of 'Statistics and probability'. Content depth of SM is comparable to AI HL.

Table 18: Specialist Mathematics content which is not covered by DP mathematics subjects

Significant SM content not in AA (only)*	Significant SM content not in AI (only)*
○ Definition and distribution of sample proportions, simulations, and confidence intervals ○ Hypothesis testing	○ Proof by induction and contradiction ○ Reciprocal trigonometric ratios and identities ○ Double and compound angle identities

○ Slope fields ○ Graphs and decision mathematics** ○ Matrices (transformations)**	○ Partial fractions ○ Rational functions ○ Absolute value function ○ Implicit differentiation ○ Counting principles**
Significant content not in either DP mathematics subject*	
○ Proof (circle theorems and geometric properties) ○ Locus definition and construction in the plane of lines, parabolas, circles, ellipses and hyperbolas ○ Cartesian, polar and parametric forms and graphs of lines, parabolas, circles, ellipses and hyperbolas ○ Polar form and graphs of other relations in the plane such as limaçons, cardioids, roses, lemniscates and spirals ○ Parametric form and graphs of other relations in the plane such as spirals, cycloids, lissajous figures and epicycles ○ Vector calculus Larger topics: ○ Mechanics ○ Logic and Algebra** ○ Kinematics**	

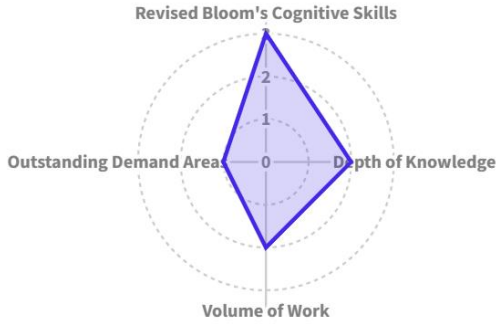
*Significant content does not include topics which are typical to mathematical learning prior to upper secondary
**Optional content

5.1.3 Demand – Mathematics

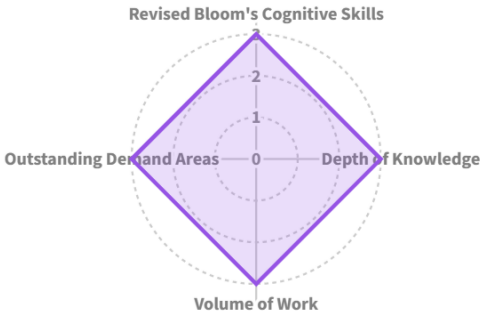
The DP and VCE curricula were analysed using the same demand tool in order to create a demand profile for mathematics: analysis and approaches (SL and HL), mathematics: applications and interpretation (SL and HL), VCE Foundation Mathematics, VCE General Mathematics, VCE Further Mathematics, VCE Mathematical Methods, and VCE Specialist Mathematics. These demand profiles are presented below in the form of radar diagrams, with the last diagram showing all DP and VCE profiles superimposed in one place, enabling immediate visual comparison.

Figure 14: Visual representations of subject demand

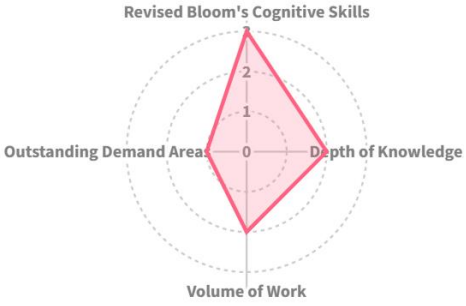
DP mathematics: analysis and approaches SL



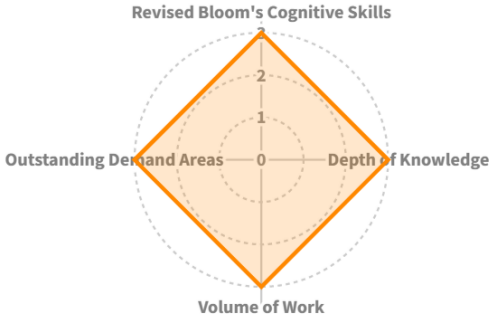
DP mathematics: analysis and approaches HL



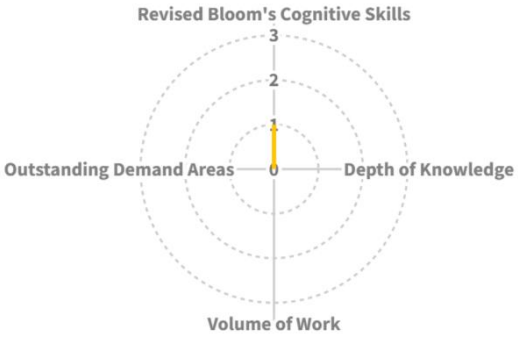
DP mathematics: applications and interpretation SL



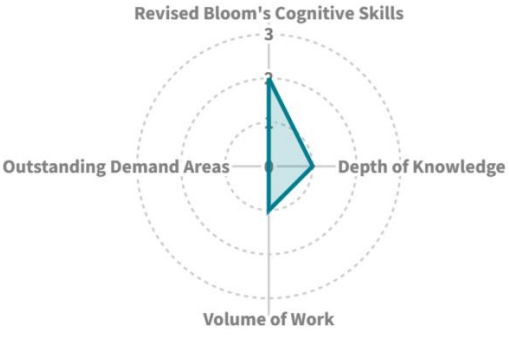
DP mathematics: applications and interpretation HL



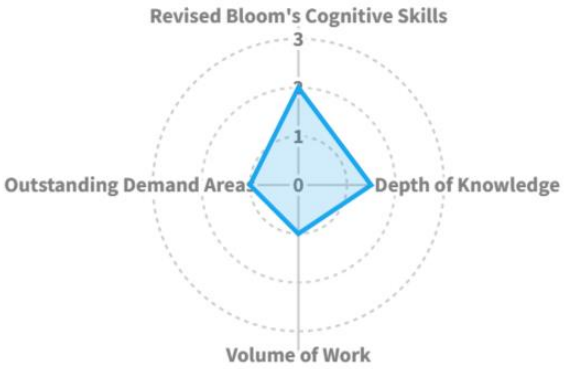
VCE Foundation Mathematics



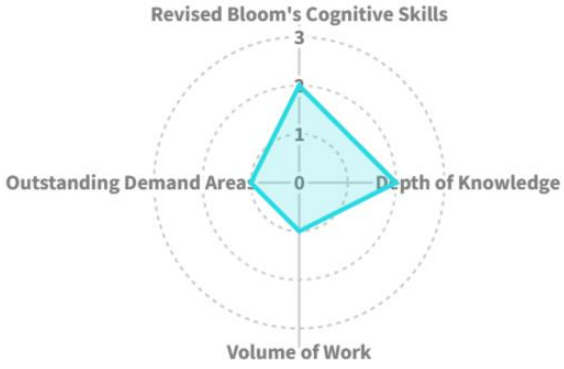
VCE General Mathematics



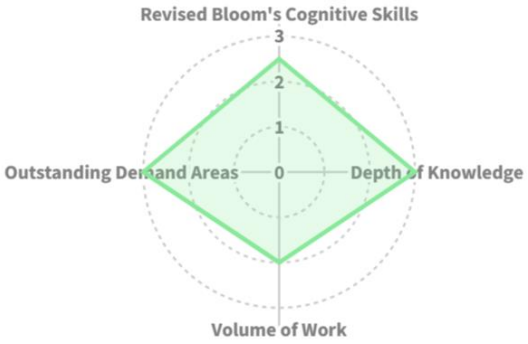
VCE Further Mathematics



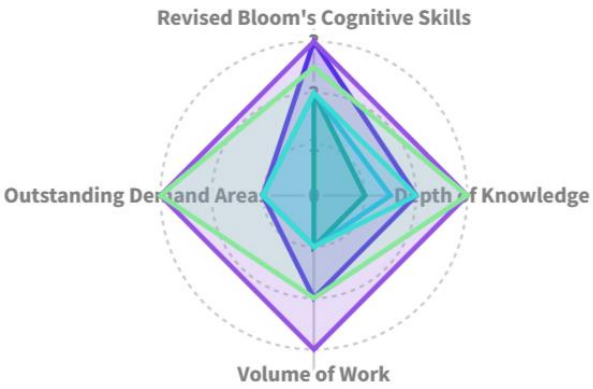
VCE Mathematical Methods



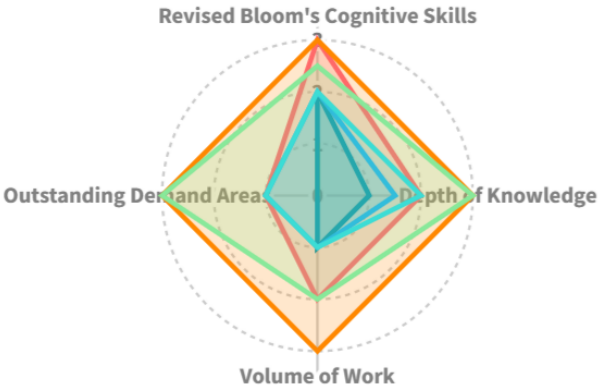
VCE Specialist Mathematics



DP AA SL/HL and VCE subjects



DP AI SL/HL and VCE subjects



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 learning outcomes apply to all subjects; hence the scores are the same for mathematics: analysis and approaches (SL and HL) and mathematics: applications and interpretation (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.
  - For the VCE, each subject is scored separately – since both the general 'aims' and the subject-specific 'Outcomes' were used in demand decisions. Due to being more comprehensive, the subject-specific outcomes had precedence in the decision-making, however panel discussions noted that this specificity may lead to some VCE subjects receiving lower scores than others, which is not the case for subjects in curricula describing generalised outcomes only. Foundation Mathematics was given a score of 1 due to the overall emphasis on understanding and application of knowledge and limited evidence of higher order thinking skills. General Mathematics, Further Mathematics, and Mathematical Methods all received a score of 2 as their outcomes had more references to analysis and investigation but lacked complex reasoning and evaluation. Specialist Mathematics was given a score of 2.5 to reflect the higher order cognitive skills that its content material would demand, though evaluation and criticality were not present enough to justify a score of 3. Overall, the presence of higher order cognitive skills varied in the VCE's subject outcomes, however none evidenced them as strongly as DP mathematics outcomes.

- Regarding the scores for **Depth of Knowledge**:
  - For the DP, both mathematics subjects at SL were deemed to merit a score of 2 for depth of knowledge. 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.
  - Looking at VCE subjects, Foundation Mathematics was given a score of 0 due to the basic nature of its content which was more typical of learning prior to upper-secondary mathematics. General Mathematics was awarded a score of 1, due to the inclusion of some sub-topics requiring study of new material and some pre-requisite knowledge, though generally these only contributed to main topics being studied in limited/some detail. A score of 1.5 was awarded for Further Mathematics as statistics and finance were studied in good, but not considerable detail. The subject went beyond a score of 1 for having sub-topics which were studied in greater detail than in General Mathematics, and thus required greater levels of pre-requisite knowledge. Mathematical Methods was deemed to cover the topics of

'Algebra', 'Functions', 'Statistics and probability', and 'Calculus' in considerable detail, similar to DP SL, hence a score of 2 was awarded. Finally, Specialist Mathematics covered topics in high levels of detail, extending each topic to include more advanced sub-topics which built upon the previous and thus increasing the level of complexity, hence it was awarded the same level 3 score as the DP HL subjects.

- Regarding the scores for **Volume of Work**:
  - The DP SL mathematics subjects were each 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 Victoria, Foundation Mathematics had 100 hours to cover a very light amount of content and received a score of 0 for volume of work. General Mathematics and Further Mathematics each had 100 teaching hours and Mathematical Methods had 200 teaching hours, all of which were deemed standard time allocations to cover the topics within them and hence a score of 1 was given to each. Finally, Specialist Mathematics covered complex material in Units 3 & 4, with a time allocation of 100 hours, thus was deemed to lean towards a heavy workload. However, when considering the content learnt by the end of Specialist Mathematics (Mathematical Methods inclusive) the teaching hours total 400 - substantially more than the 240 hours for DP HL (though it can be noted that Specialist Mathematics covers several further topics). On average, given that some units had a standard volume of work, whilst others were more intensive, a score of 2 was deemed suitable for this subject.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - Both DP mathematics subjects at SL 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 Victoria, Foundational Mathematics and General Mathematics did not contain any areas of outstanding demand and were each awarded a score of 0. Further

Mathematics had one or two areas of demand, identified as modelling time series data and transition matrices, and received a score of 1. Similarly, Mathematical Methods was also awarded a score of 1 for the inclusion of extended modelling and problem-solving tasks. Similar tasks were also present in Further Mathematics; however, these were not credited as another area of outstanding demand due to being described as 'teacher-led' in these units. Finally, Specialist Mathematics had further outstanding areas of demand identified, which were proof by induction, complex numbers (De Moivre's theorem), slope fields, second order differential equations and vector calculus. Therefore, similarly to DP HL subjects, a score of 3 was awarded in this category.

5.2 Physics

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

DP physics[77]
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 in the HL. Thus, the 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.

VCE physics[78]
The VCE physics course is typically taken in the final two years of secondary education in Victoria, Years 11 and 12, and comprises four units of study. The units cover four distinct themes in physics and are inquiry based. Unit 1 focuses on how ideas explain the physical world whilst Unit 2 is focused on experimental approaches and techniques in physics. Unit 3 is based on fields, motion and electricity and Unit 4 explores how two contradictory models explain light and matter. Students are not required to take all units (they may take Units 1 and 2 for example without progressing onto Units 3 and 4), and there are no prerequisites for Units 1-3, whereas Unit 4 requires completion of the previous three units of study.

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 taken from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for physics, chemistry, and biology. Similarly, the VCE curriculum sets out subject aims for the sciences, which detail a range of intended skills and competencies on a subject level. The VCE curriculum also sets out key science skills which specify the generic scientific competencies

[77] International Baccalaureate. (2023). *Physics guide.*
[78] Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Physics Study Design*.

that students are expected to develop and demonstrate throughout all four physics units. These are included in the cross-study specifications section of the curriculum as they apply to science subjects in general. However, in contrast to the DP, the aims and key science skills in the VCE are contextualised for each individual science – though the main concepts remain the same.

As well as the aims and key science skills, the VCE curriculum includes physics-specific outcomes. Indeed, each 'area of study' in a physics unit contains three 'outcomes' – listing topic-specific statements that address key knowledge and key skills. This differs to the DP, which does not set out specific physics outcomes. However, since the VCE's sciences aims and key skills are detailed, the analysis mostly focuses on these, rather than the topic-specific outcomes in the areas of study of individual sciences.

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 VCE physics curricula.

Table 19: Presence of the DP sciences learning outcome themes in the VCE science/physics learning outcomes

Themes extracted from the learning outcomes of the DP sciences subject group	Presence in VCE	
1. Conceptual understanding and making connections		Somewhat present. Developing conceptual understanding is not an explicit focus of the aims and key science skills
2. Acquisition and application of knowledge, methods, tools, and techniques that characterise science		Present. Found in both aims and key science skills
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present. Found in both aims and key science skills
4. Skills for scientific inquiry		Present. Found in both aims and key science skills
5. Development of technological skills		Present. Found in the key science skills
6. Effective collaboration and communication		Present. Found in both aims and key science skills
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. Found in both aims and key science skills

Key:

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

Presence of the DP's Learning Outcome Themes

The DP's learning outcome themes are found to be present in the aims and key science skills specified for all sciences – contextualised for physics. Application of scientific knowledge, methods, tools, and techniques are well evidenced in the VCE curricula. Examples of relevant key science skills from the VCE curriculum relating to application include 'solve a scientific or technological problem' and 'select and use scientific procedures'. Explicit reference to scientific application is also evident in the VCE aims, which include 'apply physics models, theories and concepts to describe, explain, analyse and make predictions…'. Application, particularly in the context of problem solving, is also evident at unit level in outcomes (across all four units) which require the student to 'solve', 'calculate' and 'apply'.

Equally, the aims and key science skills strongly evidence the DP's theme of using creative and critical thinking, as references to analysing, evaluating, and problem-solving are frequently used throughout. Some specific examples relating to this theme are 'critically evaluate various types of information related to physics from journal articles, mass media and opinions presented in the public domain' and 'analyse and evaluate data, methods and scientific models'. Another strong theme in the VCE is that of developing science inquiry skills. The key science skills especially related to this theme include 'Plan and undertake investigations', 'Develop aims and questions, formulate hypotheses and make predictions', 'Comply with safety and ethical guidelines', and 'Draw evidence-based conclusions'.

Communication and collaboration skills, as well as communication of scientific ideas, are referenced throughout the units of the VCE and are explicitly included in the aims and key science skills. For example, the VCE key science skills describe that a student should be able to 'acknowledge sources of information and use standard scientific referencing conventions' and develop 'a range of individual and collaborative science investigation skills'. Moreover, the aims state that students should be enabled to 'communicate clearly and accurately an understanding of the discipline using appropriate terminology, conventions and formats'. Furthermore, the theme of developing technological skills is also present in the key science skills, which reference 'solving technological problems'.

Regarding the DP's theme of awareness of global and local issues and the ethical, environmental, societal, and cultural impact of science, the VCE curricula demonstrate this theme mostly in their aims. Indeed, the aims similarly state that students should 'develop an informed perspective on contemporary science-based issues of local and global significance' and 'understand the cooperative, cumulative, evolutionary and interdisciplinary nature of science as a human endeavour, including its possibilities, limitations and political and sociocultural influences'. While the VCE places similar emphasis on this theme, it can be noted that ethical implications are only referenced with regard to investigations in the key science skills, and cultural references are not included explicitly.

Finally, conceptual understanding, or indeed developing understanding, is not a focus of the aims and key science skills of VCE physics. That said, this theme is somewhat present as one

skill states that students should be able to 'discuss relevant physics information, ideas, concepts, theories and models and the connections between them' – serving as an example where having a sound knowledge and understanding is critical to acquiring the ability to discuss the relevant theories.

Other Themes in the VCE

Although mainly skills-focused, the VCE aims also provide additional detail on the attitudes and values intended to be developed in students throughout the study. For example, VCE students are supposed to 'develop attitudes that include curiosity, open-mindedness, creativity, flexibility, integrity, attention to detail and respect for evidence-based conclusions'. These attitudes fall outside of the scope of the DP learning outcome themes but may relate more to the attributes expressed in the IB learner profile, for example 'Risk Taker', 'Open-Minded' and 'Principled'.

Summary

In summary, there are a number of similarities in terms of the skills and knowledge areas that are expected to be covered in DP and VCE physics. The VCE curricula, while exhibiting a strong focus on critical thinking and investigation skills, demonstrate coverage of a number of skills also included in the DP outcome themes including application, wider awareness, technology, communication, and collaboration. Some differences are identified and relate to choice of emphasis in the learning outcomes. Nevertheless, overall alignment is found to be evident between outcome themes of the DP and VCE physics.

5.2.2 Content – Physics

This section will comparatively review the content of the DP and VCE physics curricula falling within the category of physics. In order to support visual comparison at-a-glance, the DP and VCE physics curricula are presented below in diagrams which show the key topics and sub-topics included in each.

Figure 15: DP physics content visualiser[79]

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		

[79] '(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: VCE physics content visualiser

Unit 1: What ideas explain the physical world?	Area of study 1: How can thermal effects be explained?	Thermodynamics principles	Thermodynamics and climate science	Issues related to thermodynamics	
	Area of Study 2: How do electric circuits work?	Concepts used to model electricity	Circuit electricity	Using electricity	Electrical safety
	Area of Study 3: What is matter and how is it formed?	Origins of atoms	Particles in the nucleus	Energy from the atom	
Unit 2: What do experiments reveal about the physical world?	Area of study 1: How can motion be described and explained?	Concepts used to model motion	Forces and motion	Energy and motion	
	Area of Study 2: Options	What are stars?; Is there life beyond Earth's Solar System?; How do forces act on the human body?; How can AC electricity charge a DC device?; How do heavy things fly?; How do fusion and fission compare as viable nuclear energy power sources?; How is radiation used to maintain human health?; How do particle accelerators work?; How can human vision be enhanced?; How do instruments make music?; How can performance in ball sports be improved?; How does the human body use electricity?			
	Area of Study 3: Practical Investigation	On completion of this unit the student should be able to design and undertake an investigation of a physics question related to the scientific inquiry processes of data collection and analysis, and draw conclusions based on evidence from collected data			
Unit 3: How do fields explain motion and electricity?	Area of Study 1: How do things move without contact?	Fields and interactions	Effects of fields	Application of field concepts	
	Area of Study 2: How are fields used to move electrical energy?	Generation of electricity	Transmission of electricity		
	Area of Study 3: How fast can things go?	Newton's laws of motion	Einstein's theory of special relativity	Relationships between force, energy and mass	
Unit 4: How can two contradictory models explain both light and matter?	Area of Study 1: How can waves explain the behaviour of light?	Properties of mechanical waves	Light as a wave		
	Area of Study 2: How are light and matter similar?	Behaviour of light	Matter as particles or waves	Similarities between light and matter	Production of light from matter
	Area of Study 3: Practical investigation	On completion of this unit the student should be able to design and undertake a practical investigation related to waves or fields or motion, and present methodologies, findings and conclusions in a scientific poster.			

Structure

Both DP and VCE courses are designed to be covered over two years and have a similar time allocation to cover the specified content. Both have external and internal examinations. The DP subject statements are marginally more detailed than VCE subject statements, but both curricula are detailed enough to ensure all students studying them will have a common and consistent experience.

The DP physics broadly covers five themes while VCE physics covers four, with both courses allowing for content to be covered in whichever order the teacher deems appropriate. However, for VCE physics, Units 1 and 2 need to be covered in year one before progressing onto Units 3 and 4 in year two. For DP, HL content is interwoven with SL content and there is no requirement for certain content to be covered in year one before progressing to year two.

The VCE has 'options' where students select one question from a list of 12 and carry out an investigation into it. This has similarities to the Internal Assessment (IA) in the DP, though appears to be less rigorous – the students in the VCE are given a question and numerous prompts to help them address it. In the DP's IA, students must come up with their own unique research questions and, while they will have assistance from their teacher, the level of guidance provided appears to be lower than in the VCE.

Both courses allow for practical work and applications to real world scenarios, and both aim to develop similar key scientific and inquiry skills. However, the DP has a focus on developing the learner profile and more explicit concept-based learning which is absent in the VCE.

Content Alignment

To complement the analysis on content alignment, the figure below represents a simplified summary of the VCE's content alignment, at topic-level, with DP physics (SL and HL).

Figure 17: Summary of content alignment between the DP physics topics and the VCE's physics curriculum

DP physics subtopics	SL presence in VCE physics	AHL presence in VCE physics
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		

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 VCE		*Partial presence of this topic in the VCE*		*Little or no presence of this topic in the VCE*

As seen in the figure above and table below, there is significant alignment between the topic areas in VCE and DP physics, with all content covered in the VCE course, with exception of some very specific real-life examples and practical applications, being also covered by the DP.

Generally, the DP physics course at both SL and HL has a greater breadth than the VCE physics course. However, when an individual concept is covered by both the DP and VCE, it is often covered to a comparable depth. The mathematical demand is also similar for topics covered by both courses, though in places where the DP goes into more detail than the VCE, it will often do so by including more complex quantitative descriptions.

The VCE physics has significant content alignment with the DP SL, with the majority of DP SL topics being covered, at least partially, by the VCE curriculum, with exception of fusion and stars, simple harmonic motion, and gas laws, which are absent. Some SL topics are also only partially covered by the VCE, including: thermal energy transfers, current and circuits, standing waves and resonance, the Doppler effect, and motion in electromagnetic fields.

When it comes to the DP HL, only approximately 40% of content is covered to a comparable depth by the VCE physics, suggesting that the DP physics HL course will be a more challenging course for students than the VCE physics. DP physics HL topics not covered by the VCE physics include: radioactive decay, structure of the atom, the Doppler effect, simple harmonic motion and thermodynamics. For rigid body mechanics, only the basic torque equation is covered, with an option for its application in Unit 2 if selected by the student.

Overall, though both the DP SL and HL include greater breadth and depth than the VCE physics course, the DP SL has significant content alignment with the VCE, while the DP HL features substantially more content and depth.

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

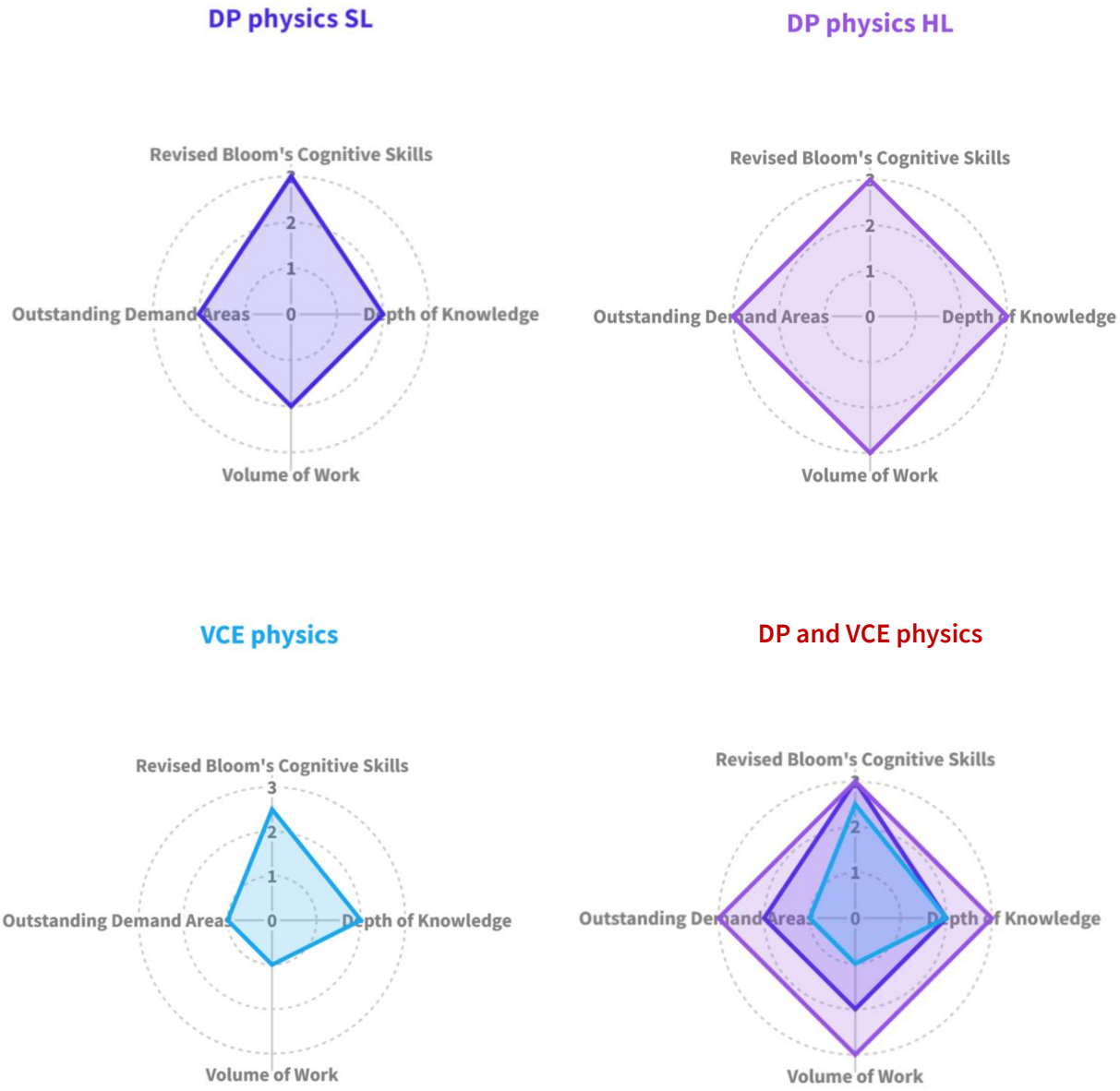
Significant content not in DP physics*
◦ All significant content in the VCE physics course is covered by DP physics. Some opportunities for application in VCE are not explicit in the DP, e.g. in issues related to thermodynamics, the content on heat pumps and air conditioning, and the content under application of flight. However, these are not highly significant aspects of the curriculum.

*Significant content does not include topics which are typical of learning prior to upper secondary level.

5.2.3 Demand – Physics

The DP and VCE curricula were analysed using the same demand tool in order to create a demand profile for DP physics SL, DP physics HL, and VCE physics. 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 18: Visual representations of subject demand



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.
  - For VCE physics, a score of 2.5 was awarded, with Units 1 and 2 deemed to meet a score of 2 and Units 3 and 4 a score of 3. There was agreement that the learning outcomes featured a predominant focus on analysis and evaluation, methods and scientific models and that some synthesis and creation skills (in the form of

investigation and research) were included too, though this was not deemed to be sufficient to meet a score of 3.

- 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.
  - For VCE physics, the cognitive complexity in the course, the (non-explicit) pre-requisites for accessing Units 1 and 2 and explicit pre-requisites for accessing Units 3 and 4, as well as a predominant focus on application of knowledge, were deemed to merit a score of 2.

- 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.
  - In contrast, the VCE physics course was attributed a score of 1 (moderate) due to the comparatively generous time allocation provided per topic studied.

- 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.
  - In VCE physics, two potential areas of stretch were identified – the student-designed practical investigation(s) outlined in Unit 2 Area of Study 3 and Unit 4 Area of Study 3, meriting a Stretch score of 1.

5.3 Chemistry

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

DP chemistry[80]

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

[80] International Baccalaureate. (2023). *Chemistry guide*.

and environmental science. HL is suitable for those intending to pursue further study in an area requiring a strong background in chemistry.

VCE chemistry[81]

VCE chemistry is typically taken in the final two years of secondary education, Years 11 and 12 and, similar to physics, includes four units of study. The units cover four themes within chemistry – Unit 1 is focused on the diversity of materials whilst Unit 2 covers the unique characteristics of water. Unit 3 focuses on chemical processes and their optimisation whereas Unit 4 is centred around organic compounds and chemistry. Students are not required to take all units and Units 1-3 do not have prerequisites; however, students taking Unit 4 are required to have completed Unit 3.

5.3.1 Learning Outcomes – Chemistry

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

Apart from some slight contextual differences, the aims and key science skills are mostly the same for all VCE sciences, hence the analysis will have similar results for chemistry as for physics. Therefore, this section will include the summary table again, followed by a shortened overview of the findings. Further detail of the analysis can be found in section 5.2.1 Learning Outcomes – Physics.

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 VCE chemistry curricula.

[81] Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Chemistry Study Design*.

Table 21: Presence of the DP sciences subject group learning outcome themes in the VCE chemistry curriculum

Themes extracted from the learning outcomes of the DP sciences subject group	Presence in VCE	
1. Conceptual understanding and making connections		Somewhat present. Developing conceptual understanding is not a focus of the aims and key science skills
2. Acquisition and application of knowledge, methods, tools, and techniques that characterise science		Present. Found in both aims and key science skills
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present. Found in both aims and key science skills
4. Skills for scientific inquiry		Present. Found in both aims and key science skills
5. Development of technological skills		Present. Found in the key science skills
6. Effective collaboration and communication		Present. Found in both aims and key science skills
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. Found in both aims and key science skills

Key:

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

Summary

The chemistry learning outcomes of the DP and VCE are highly aligned. As stated with physics, the VCE learning outcomes also have similar themes to the DP – including application, creativity and critical thinking, scientific inquiry skills, technological skills, effective communication and collaboration, and wider awareness of issues and impacts. However, it can be noted that developing conceptual understanding is not a focus of the VCE chemistry learning outcomes, though it is implied in the key science skills statement 'discuss relevant chemical information, ideas, concepts, theories and models and the connections between them'. Finally, although there are many similarities, the analysis shows that the VCE includes a statement about the types of attitudes students should develop, though it can be noted that the DP does this through its IB learner profile.

5.3.2 Content – Chemistry

This section considers the VCE and DP chemistry content and discusses the key similarities and differences in coverage. In order to support visual comparison at-a-glance, the DP and VCE chemistry curricula are summarised in the diagram below, which lists the key topics and sub-topics included in each.

Figure 19: DP chemistry content visualiser[82]

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			

[82] '(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: VCE chemistry content visualiser

Unit 1: How can the diversity of materials be explained?	Area of Study 1: How can knowledge of elements explain the properties of matter?	Elements and the periodic table	Metals	Ionic Compounds	Quantifying atoms and compounds	
	Area of Study 2: How can the versatility of non-metals be explained?	Materials from molecules	Carbon lattices and carbon nanomaterials	Organic compounds	Polymers	
	Area of Study 3: Research investigation	Options: The origin of the elements; The development of the periodic table; The lanthanoids and actinoids; Using light to solve chemical puzzles; Glass; Crude oil; Surfactants; Polymers and composite materials; Nanomaterials; The life cycle of a selected material or chemical.				
Unit 2: What makes water such a unique chemical?	Area of Study 1: How do substances interact with water?	Properties of water	Water as a solvent	Acid-base (proton transfer) reactions in water	Redox (electron transfer) reactions in water	
	Area of Study 2: How are substances in water measured and analysed?	Water sample analysis	Measurement of solubility and concentration	Analysis for salts in water	Analysis for organic compounds in water	Analysis for acids and bases in water
	Area of Study 3: Practical investigation	On completion of this unit the student should be able to design and undertake a quantitative laboratory investigation related to water quality, and draw conclusions based on evidence from collected data.				
Unit 3: How can chemical processes be designed to optimise efficiency?	Area of Study 1: What are the options for energy production?	Obtaining energy from fuels	Fuel choices	Fuel cells as a source of energy		
	Area of Study 2: How can the yield of a chemical product be optimised?	Rate of chemical reactions	Extent of chemical reactions	Production of chemicals by electrolysis	Rechargeable batteries	
	Area of Study 3: School-based assessment	The student's level of achievement in Unit 3 is determined by School-assessed Coursework. Coursework tasks are completed mainly in class and within a limited timeframe.				
Unit 4: How are organic compounds categorised, analysed and used?	Area of Study 1: How can the diversity of carbon compounds be explained and categorised?	Structure and nomenclature of organic compounds	Categories, properties and reactions of organic compounds	Analysis of organic compounds		
	Area of Study 2: What is the chemistry of food?	Key food molecules	Metabolism of food in the human body	Energy content of food		
	Area of Study 3: Practical investigation	On completion of this unit the student should be able to design and undertake a practical investigation related to waves or fields or motion, and present methodologies, findings and conclusions in a scientific poster.				

Structure

In the VCE curriculum, there is one pathway, with students studying all high school science topics outlined. In contrast, the DP provides two routes for learning, SL and HL, with the HL chemistry content being more conceptually demanding and explored in greater depth.

As with physics, the VCE chemistry course is arranged into four units spanning the course of two years. Within each unit, there are up to three areas of study, with Area of Study 1 focusing on acquisition of knowledge and subsequent areas featuring a greater emphasis on application of knowledge and practical investigations. These units are prefaced with the expected science skills and how students should communicate their understanding from investigations. Like the VCE chemistry course, DP chemistry provides guiding questions for each unit, in addition to this DP chemistry comprises six syllabus components that incorporate understandings, learning outcomes, and links to the 'Skills of the study of chemistry' and 'Nature of science'.

The main structural difference between the two courses lies in the order and extent to which content is typically taught. In the DP, topics taught at HL to some extent build on content covered in SL, whereas in the VCE chemistry there is less progression in terms of the content between units, with no prerequisite content from Unit 1 being required to take Units 2 and 3, for example.

Content Alignment

To complement the analysis on content alignment, the figure below represents a simplified summary of the VCE's content alignment, at topic-level, with DP chemistry (SL and HL).

Figure 21: Summary of content alignment between the DP chemistry topics and the VCE's chemistry curriculum

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

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

Key:

	Strong presence of this topic in the VCE		*Partial presence of this topic in the VCE*		*Little or no presence of this topics in the VCE*

There is a high level of content alignment between the DP chemistry SL and the VCE chemistry. As can be seen above, the majority of DP chemistry SL topic areas is also covered in the VCE chemistry, with exception of energy cycles in reactions, electron sharing reactions, and electron-pair sharing reactions.

The VCE also offers coverage of approximately half of the AHL content in the DP chemistry HL, offering considerable coverage of a number of sub-topics, including periodicity, the metallic model, classification of organic compounds. However, differences in depth are apparent, for example, in thermochemistry, with no direct reference to coverage of Hess's Law and energy cycles in the VCE chemistry. Furthermore, although some coverage of bonding and energy diagrams is included in the VCE chemistry, bond enthalpies overall are not covered in comparable depth to the DP HL. Other DP HL areas not included in the VCE chemistry include entropy, hybridization, activation energy, Lewis acids and bases and pH curves.

There are also some areas covered in the VCE chemistry content which are not covered in the DP chemistry. Some of the most significant ones include Faraday's law calculations, Carbon 13 nuclear magnetic resonance (NMR), properties and analysis of water, key food molecules and metabolism in the human body (though the last three are covered in DP biology).

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

Significant VCE chemistry content which is not included in the DP*
○ Properties and analysis of water ○ Carbon 13 nuclear magnetic resonance ○ Key food molecules ○ Metabolism of food in the human body ○ Faraday's law calculations ○ Option topics Unit 1 AOS 3 – Life cycle assessments, Nanoparticles, Surfactants, Synchrotron light, Lanthanoids and actinoids, The origin of elements, The development of the periodic table (NB: students only select one option).

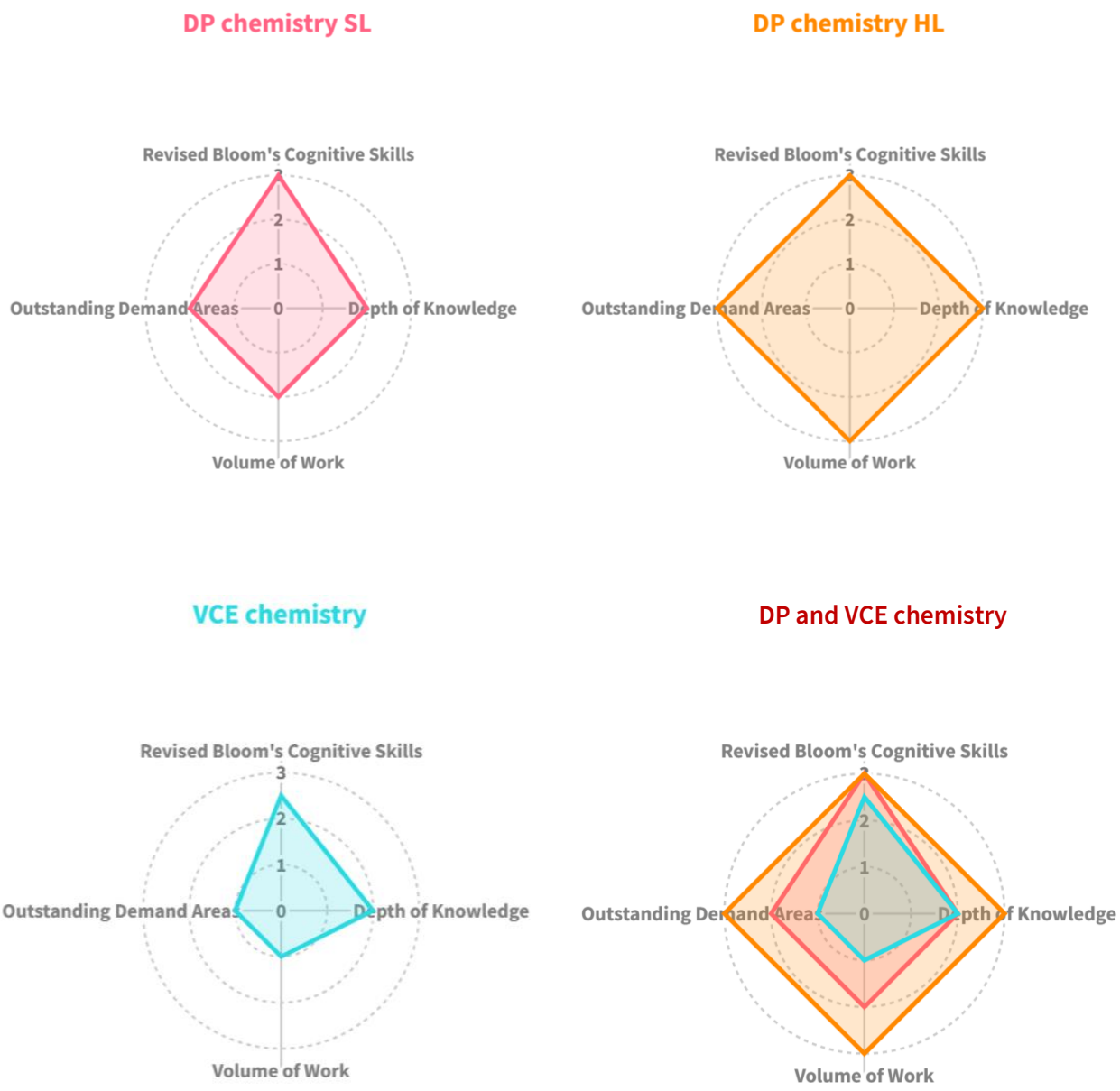
*Significant content mostly does not include topics which are typically studied *prior* to upper secondary

Overall, the VCE chemistry has a strong level of alignment with the DP chemistry SL, and some alignment with the DP chemistry HL, though a significant proportion of the AHL content is not covered.

5.3.3 Demand – Chemistry

The DP and VCE curricula were analysed using the same demand tool in order to create a demand profile for DP chemistry SL, DP chemistry HL, and VCE chemistry. 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



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.
  - For VCE chemistry, a score of 2.5 was awarded, with Units 1 and 2 deemed to meet a score of 2 and Units 3 and 4 a score of 3. There was agreement that the learning outcomes featured a predominant focus on analysis and evaluation, methods and scientific models and that some synthesis and creation skills (in the form of investigation and research) were included too, though this was not deemed to be sufficient to meet a score of 3.

- 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.
  - For VCE chemistry, the cognitive complexity in the course, the (non-explicit) pre-requisites for accessing Units 1 and 2 and explicit pre-requisites for accessing Units 3 and 4, as well as a predominant focus on application of knowledge, were deemed to merit a score of 2.

- 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.
  - In contrast, the VCE chemistry course was attributed a score of 1 (moderate) due to the comparatively generous time allocation provided per topic studied.

- 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.

- In VCE chemistry, the research investigation outlined in Unit 1 Area of Study 3 and the student-designed practical investigation on water quality outlined in Unit 2 Area of Study 3 were identified as areas of stretch, meriting a stretch score of 1.

5.4 Biology

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

DP biology[83]
Biology is a subject option within the DP sciences subject group, offered at both SL and HL. This subject offers 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.

VCE biology[84]
VCE biology is typically taken in the final two years of secondary education, Years 11 and 12 and, similar to VCE physics and chemistry, includes four units of study. The units cover four inquiry led questions within biology – Unit 1 is focused on how organisms regulate their functions, while Unit 2 focuses on inheritance and its impact on diversity. Unit 3 asks the question 'How do cells maintain life?' and Unit 4 is centred on how life evolves and responds to challenges. There are no prerequisites for entry to Units 1, 2 and 3; however, students are required to have taken Unit 3 prior to Unit 4.

5.4.1 Learning Outcomes – Biology

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

Apart from some slight contextual differences, the aims and key science skills are mostly the same for all VCE sciences, hence the analysis will have similar results for biology as for physics. However, the recently revised VCE biology curriculum does contain some small differences to the older physics and chemistry curricula in its learning outcomes, hence it is important that these are noted. Therefore, this section will include the summary table again, followed by a shortened overview of the findings – which will include biology-specific differences. Further detail of the analysis can be found in section 5.2.1 Learning Outcomes - Physics.

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 VCE biology curricula.

[83] International Baccalaureate. (2023). *Biology guide*.
[84] Victorian Curriculum and Assessment Authority. (2020). *Victorian Certificate of Education. Biology Study Design*.

Table 23: Presence of the DP sciences learning outcome themes in the VCE science/biology curricula

Themes extracted from the learning outcomes of the DP sciences subject group	Presence in VCE	
1. Conceptual understanding and making connections		Present. Developing understanding has a stronger focus in the aims of the recently updated biology curriculum
2. Acquisition and application of knowledge, methods, tools, and techniques that characterise science		Present. Found in both aims and key science skills
3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis)		Present. Found in both aims and key science skills
4. Skills for scientific inquiry		Present. Found in both aims and key science skills
5. Development of technological skills		Present. Found in the key science skills
6. Effective collaboration and communication		Present. Found in both aims and key science skills
7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science		Present. Found in both aims and key science skills

Key:

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

Summary

The biology learning outcomes of the DP and VCE are highly aligned. As stated with physics and chemistry, the VCE learning outcomes also have similar themes to the DP – including application, creativity and critical thinking, scientific inquiry skills, technological skills, effective communication and collaboration, and wider awareness of issues and impacts. Furthermore, the more recently revised biology curriculum places a higher emphasis on the development of understanding, hence this DP theme is stronger in biology than physics and chemistry. Indeed, the aims in VCE biology state that students should:

- develop knowledge and understanding of key biological models, theories, concepts and issues from the individual cell to species level

- develop knowledge and understanding of organisms, their relationship to their environment, and the consequences of biological change over time, including the impact of human endeavours on biological processes and the survival of species
- develop knowledge and understanding of key models, concepts, theories and laws of science to explain scientific processes and phenomena, and apply this understanding in familiar and unfamiliar situations, including personal, sociocultural, environmental and technological contexts

Additionally, it is also stated in the key science skills that students should 'discuss relevant biological information, ideas, concepts, theories and models and the connections between them'. Combining these statements together, it is clear that the VCE aims to develop understanding and allow for connections to be made in biology, although it can be noted that conceptual understanding is not explicitly referenced. Another, smaller, difference in VCE biology is the included statement in the key science skills that students should 'analyse and evaluate bioethical issues using relevant approaches to bioethics and ethical concepts, including the influence of social, economic, legal and political factors relevant to the selected issue'. Therefore, the inclusion of this statement strengthens the presence of the DP's theme of the impact of science. It can be noted that when the VCE revises its physics and chemistry curricula, they likely will also present these new changes.

Finally, although there are many similarities, a difference of note is that the VCE includes a statement about the types of attitudes students should develop, though the DP does this through its IB learner profile.

5.4.2 Content – Biology

This section includes a comparison of the content of the DP and VCE biology curricula. In order to support visual comparison at-a-glance, the DP and VCE biology curricula are presented below in diagrams which show the key topics and sub-topics included in each.

Figure 23: DP biology content visualiser[85]

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	

[85] '(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: VCE biology content visualiser

Unit 1: How do organisms regulate their functions?	Area of Study 1: How do cells function?	Cellular structure and function	The cell cycle and cell growth, death and differentiation		
	Area of Study 2: How do plant and animal systems function?	Functioning systems	Regulation of systems		
	Area of Study 3: How do scientific investigations develop understanding of how organisms regulate their functions?	On completion of this unit the student should be able to adapt or design and then conduct a scientific investigation related to function and/or regulation of cells or systems, and draw a conclusion based on evidence from generated primary data.			
Unit 2: How does inheritance impact on diversity?	Area of Study 1: How is inheritance explained?	From chromosomes to genomes	Genotypes and phenotypes	Patterns of inheritance	
	Area of Study 2: How do inherited adaptations impact on diversity?	Reproductive strategies	Adaptations and diversity		
	Area of Study 3: How do humans use science to explore and communicate contemporary bioethical issues?	On completion of this unit the student should be able to identify, analyse and evaluate a bioethical issue in genetics, reproductive science or adaptations beneficial for survival.			
Unit 3: How do cells maintain life?	Area of Study 1: What is the role of nucleic acids and proteins in maintaining life?	The relationship between nucleic acids and proteins	DNA manipulation techniques and applications		
	Area of Study 2: How are biochemical pathways regulated?	Regulation of biochemical pathways in photosynthesis and cellular respiration	Photosynthesis as an example of biochemical pathways	Cellular respiration as an example of biochemical pathways	Biotechnological applications of biochemical pathways
	Area of Study 3: School-based assessment	The student's level of achievement in Unit 3 is determined by School-assessed Coursework. Coursework tasks are completed mainly in class and within a limited timeframe.			
Unit 4: How does life change and respond to challenges?	Area of Study 1: How do organisms respond to pathogens?	Responding to antigens	Acquiring immunity	Disease challenges and strategies	
	Area of Study 2: How are species related over time?	Genetic changes in a population over time	Changes in species over time	Determining the relatedness of species	Human change over time
	Area of Study 3: How is scientific inquiry used to investigate cellular processes and/or biological change?	On completion of this unit the student should be able to design and conduct a scientific investigation related to cellular processes and/or how life changes and responds to challenges, and present an aim, methodology and methods, results, discussion and a conclusion in a scientific poster.			

Structure

As with physics and chemistry, the VCE biology curriculum features only one pathway, with students studying all the topics to the same level of detail. In contrast, the DP biology provides two routes for learning, SL and HL, with the HL biology content being more conceptually demanding and explored in greater depth.

The VCE biology course is arranged into four units spanning the course of two years. Within each unit, there are up to three areas of study, with Area of Study 1 focusing on acquisition of knowledge and subsequent areas featuring a greater focus on application of knowledge and practical investigations. These units are prefaced with the expected science skills and how students should communicate their understanding from investigations.

Similar to VCE biology, DP biology provides guiding questions for each unit, but this is in addition to four themes that are explored at four organisational levels, providing a total of 16 topics and 35 subtopics in the SL course and 40 subtopics in the HL. All subtopics contain components that incorporate key understandings, learning outcomes, and links to the 'Skills of the study of biology' and 'Nature of science'.

There are some differences in how the content and knowledge areas are structured. In the VCE biology, the design of the programme is centred around inquiry questions so the content that follows naturally relates to the question being asked which is specific to the theme of each unit. There is minor overlap between units, but in the most part prerequisite knowledge from one unit is not required in order to progress onto the next. In the DP, however, content is organised in a more sequential fashion, with fundamental knowledge in the SL core subsequently being built upon in the HL topic areas. An example of this progressive nature of the DP is in regard to homeostasis, where the fundamentals are covered in the SL core and more advanced and detailed knowledge of the biological and chemical processes involved is subsequently covered in later HL topics.

Content Alignment

To complement the analysis on content alignment, the figure below represents a simplified summary of the VCE's content alignment, at topic-level, with DP biology (SL and HL).

Figure 25: Summary of content alignment between the DP biology topics and the VCE's biology curriculum

DP biology topics	Presence of SL content in the VCE	Presence of AHL content in the VCE
A1 Unity and diversity – Molecules		
A2 Unity and diversity – Cells		
A3 Unity and diversity – Organisms		
A4 Unity and diversity – Ecosystems		
B1 Form and function – Molecules		
B2 Form and function – Cells		
B3 Form and function – Organisms		
B4 Form and function – Ecosystems		N/A
C1 Interaction and independence – Molecules		
C2 Interaction and independence – Cells		
C3 Interaction and independence – Organisms		
C4 Interaction and independence – Ecosystems		N/A
D1 Continuity and change – Molecules		

D2 Continuity and change – Cells		
D3 Continuity and change – Organisms		
D4 Continuity and change – Climate Change		
Experimental programme		

Key:

	Strong presence of this topic in the VCE		*Partial presence of this topic in the VCE*		*Little or no presence of this topic in the VCE*

As can be seen in the figure above, there is substantial topic and sub-topic level alignment between the VCE biology and the DP biology SL, with only seven out of the 35 sub-topics in the DP being absent from the VCE biology curriculum. These are: carbohydrates and lipids, transport, ecological niches, neural signalling, transfers of energy and matter, sustainability and change, and climate change. However, some SL sub-topics are covered by the VCE in a lower level of detail and depth, including: proteins, membranes and transport, gas exchange, adaptation to environment, integration of body systems, populations and communities, mutations and gene editing, and reproduction.

The VCE course does cover some of the AHL content present in the HL course's additional topics and sub-topics, though not always in the same depth. In particular, the VCE features some coverage of two out of five HL-only topics, viruses and gene expression, though this coverage is relatively limited, for example, viruses only seem to be briefly covered when studying the consequences of viral antigenic drift and shift, while the HL treats viruses as a sub-topic in itself, covering viral structures as well as lytic and lysogenic cycles. The remaining three HL-only topics – muscle and mobility, chemical signalling and origins of cells – are largely absent from the VCE, as is the AHL content across a number of sub-topics, namely water, nucleic acids, evolution and speciation, membranes and membrane transport, cell specialisation, gas exchange, transport, neural signalling, integration of body systems, reproduction, homeostasis, sustainability, and change and climate change.

In summary, while there is substantial topic and sub-topic alignment between the DP and the VCE biology curricula, the latter has stronger content alignment with the SL course in breadth and depth, with the HL course covering more topics in more depth.

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

Significant VCE biology content which is not included in the DP*
○ No significant VCE biology content was found to be absent from the DP biology course.

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

5.4.3 Demand – Biology

The DP and VCE curricula were analysed using the same demand tool in order to create a demand profile for DP biology SL, DP biology HL, and VCE biology. 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 26: Visual representations of subject demand

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.
  - For VCE biology, a score of 2.5 was awarded, with Units 1 and 2 deemed to meet a score of 2 and Units 3 and 4 scores of 3. There was agreement that the learning outcomes featured a solid focus on analysis and evaluation, methods and scientific models and that some synthesis and creation skills (in the form of investigation

and research) were included too, though this was not deemed to be sufficient to meet a score of 3.

- 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.
  - For VCE biology, the cognitive complexity and detail of the topics studied in the course, the (non-explicit) pre-requisites for accessing Units 1 and 2 and explicit pre-requisites for accessing Units 3 and 4, as well as a predominant focus on application of knowledge, were deemed to merit 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.
  - In contrast, the VCE biology course was attributed a score of 1 (moderate) due to the comparatively generous time allocation provided per topic studied.

- 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 VCE biology, a score of 0 for stretch areas was given as no particular stretch areas were identified for the course.

5.5 History

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

DP history[86]

History is a subject option within the individuals and societies subject group in the DP. History is available at SL and HL, with HL also requiring an in-depth study of three sections from one of the HL regional options and an additional exam based on this content. This subject aims to look at various perspectives and types of history (political, economic, social and cultural) in

[86] International Baccalaureate. (2015). *History guide*.

order to develop students' understanding about the past, which in turn will deepen their understanding about society and the world today.

VCE history[87]

History is offered in four units, with 1 and 2 to be taken in the first year and 3 and 4 in the second (though there are no pre-requisites for Units 1, 2, and 3). Through learning about the past and how it has shaped the present, these units aim to broaden students' perspectives and assist them in understanding the world around them.

5.5.1 Learning Outcomes – History

This section focuses on the comparative analysis of the learning outcomes between the VCE history and DP history.

For the DP history, the learning outcome themes were extracted from the group 3 aims, the History aims, and the assessment objectives. For the VCE history, the section labelled 'aims' in the syllabus was used for the mapping process.

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 VCE chemistry curricula.

Table 25: Presence of DP history learning outcome themes in VCE history learning outcomes

Themes extracted from DP history learning outcomes	Presence in VCE	
Develop knowledge and understanding of wide-ranging historical contexts		Present in the aim of exploring a range of eras and periods to build broad understanding of the past
Critical study or evaluation of diverse sources		Present in three of the seven VCE history aims
Engage with multiple perspectives and interpretations		Present in the aims expecting students to engage with historical perspectives and interpretations
Metacognition and understanding of the self and the present day		Largely present in aims about understanding the present day and the world, though the idea of understanding the self is only implicit in VCE aims
Formulate arguments through synthesis, analysis, and application		Present the aims expecting students to evaluate historical sources and apply historical thinking concepts
Reflect on the nature of History, including methods and theories		Present in three of the seven VCE history aims

Key:

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

[87] Victorian Curriculum and Assessment Authority (2020) *Victoria Certificate of Education History Study Design*.

Presence of the DP's Learning Outcome Themes

Each of the six themes extracted from DP history learning outcomes – taken from the individuals and societies subject group aims, history aims, and history assessment objectives – are present in at least one of the VCE history learning outcomes. There is, therefore, a fairly high degree of overall alignment at this level. The VCE learning outcomes show a particularly strong coverage of the themes 'Critical study or evaluation of diverse sources' and 'Reflect on the nature of History, including methods and theories'. Both of these themes are present in three of the seven VCE history aims.

Despite this, there are two elements of the DP's history learning outcome themes that are not entirely present in the VCE history aims. Firstly, although the theme 'Metacognition and understanding of the self and the present day' is present to some degree within the VCE learning outcomes, this is only through reference to the present day and not to the self. VCE history students are expected to 'appreciate that the world in which we live has not always been as it is now, and that it will continue to change in the future'. Through achieving this outcome, they will likely gain an understanding of how the present day is shaped by the past and therefore how changeable some aspects of the present day are. However, the VCE aim does not explicitly expect students to make the next step towards understanding themselves and their own perspectives, by seeing themselves within the present day. It could be argued that self-understanding and metacognition are implicit within an appreciation of how the past shapes the present, but it is certainly more explicit within the DP's history learning outcomes. The latter includes ideas such as 'increase students' understanding of themselves' and 'learning is relevant to […] the culture in which the student lives'.

Secondly, the DP history learning outcomes include the theme 'Reflect on the nature of history, including methods and theories'. The VCE history learning outcomes include most of this theme across various different aims, though perhaps with less explicit reference to the reflection upon theories. Again, it could be argued that this is implicit within the expectation that students 'engage with historical interpretations and contested debates', however, the reference to various overarching 'theories' is not as explicit as the DP's focus on getting students 'to analyse critically and to evaluate theories, concepts and arguments about the nature and activities of the individual and society'. It should be noted that the DP's reference to 'theories' falls within the wider individuals and societies subject group aims, rather than the specific history aims or assessment objectives, so the DP's own learning outcomes are not as explicit here as they are in some other areas. Nevertheless, this is a small yet significant thematic element which is more explicit in the DP than in VCE's learning outcomes.

Taken as a whole, the alignment between the learning outcomes of these two programmes is high. The same six themes accurately capture the vast majority of learning outcomes content in both.

Other Themes in the VCE

VCE history's learning outcomes align fairly strongly with the DP's. However, there are some specific references within the VCE learning outcomes which are either absent or only implicit within the DP's learning outcomes. Firstly, a VCE aim precisely lists a number of historical concepts which should be understood and applied: 'evidence, cause and consequence, continuity and change, and significance'. Apart from 'evidence', the DP does not specifically

name or list these concepts in its learning outcomes. The DP does, though, make multiple references to understanding and applying historical concepts, and those listed by VCE history are the most likely candidates by far to emerge in practice.

Another small component present within the VCE learning outcomes, which is not entirely present in the DP's, relates to the fact that these each have slightly different emphases on how the study of history links to building an understanding of the present. Whereas the DP more explicitly links history's relationship with the present day to self-understanding, the VCE learning outcomes describe understanding how the past links to 'decision-making in the present' and how the world 'will continue to change in the future'. These comments in the VCE learning outcomes contain a sense of focusing on how history impacts politics and political thinking, whereas the DP link between history and the present is more tied to the political self rather than political decisions in the abstract.

Overall, these are differences at the level of emphasis and articulation rather than large divergences in what the learning outcomes of both subjects choose to engage with.

5.5.2 Content – History

This section includes a comparison of the content of the DP and VCE history curricula. In order to support visual comparison at-a-glance, the DP and VCE history curricula are presented below in diagrams which show the key topics and sub-topics included in each.

Figure 27: DP history content visualiser

Prescribed subjects		World history topics		HL options: Depth studies		Internal investigation
1. Military leaders	Genghis Khan (c1200-1227) Richard I of England (1173-1199) Leadership Campaigns Impact	**1. Society and economy (750-1400) - Content and Context**	Society and economy Cultural and intellectual developments Religion and society	**1. History of Africa and the Middle East**	18 topics ranging from 750-2005 across a range of concepts and themes	**A historical investigation into a topic of their choice**
		2. Causes and effects of wars (750-1500) - content and context	Types and causes of conflicts Course, practices and outcomes Effects			
2. Conquest and its impact	The final stages of Muslim rule in Spain The conquest of Mexico and Peru (1519-1551) Conflict and motives Key events and actors Impact	**3. Dynasties and rulers (750–1500) - content and context**	Dynasties and rulers Law, governing institutions and administration Challenges	**2. History of the Americas**	18 topics ranging from 750-2005 across a range of concepts and themes	
		4. Societies in transition (1400–1700) - content and context	Social and economic change Cultural and intellectual change Religious change			
3. The move to global war	Japanese expansion in East Asia (1931-1941) German and Italian expansion (1933-1940) Causes of expansion Events Responses	**5. Early Modern states (1450–1789) - content and context**	Nature of power and rule Expansion Conflicts and challenges	**3. History of Asia and Oceania**	18 topics ranging from 750-2005 across a range of concepts and themes	
		6. Causes and effects of Early Modern wars (1500–1750) – content and context	Causes of conflicts Practices and impact on outcome Effects			
4. Rights and protest	Civil rights movement in the United States (1954-1965) Apartheid South Africa (1948-1964) Nature and characteristics of discrimination	**7. Origins, development and impact of industrialization (1750–2005) - content and context**	The origins of industrialization The impact and significance of key developments The social and political impact of industrialization	**4. History of Europe**	18 topics ranging from 1066-2000 across a range of concepts and themes	

Prescribed subjects		World history topics		HL options: Depth studies		Internal investigation
	Protests and action The role and significance of key actors/groups	**8. Independence movements (1800–2000) - content and context**	Origins and rise of independence movements, up to the point of independence Methods used and reasons for success Challenges faced in the first 10 years, and responses to the challenges			
5. Conflict and intervention	Rwanda (1990-1998) Kosovo (1989-2002) Causes of the conflict Course and interventions Impact	**9. Emergence and development of democratic states (1848–2000) - content and context**	Emergence of democratic states The development of democratic states Aims and results of policies			
		10. Authoritarian states (20th century) - content and context	Emergence of authoritarian states Consolidation and maintenance of power Aims and results of policies			
		11. Causes and effects of 20th-century wars - content and context	Causes of war Practices of war and their impact on the outcome Effects of war			
		12. The Cold War: Superpower tensions and rivalries (20th century) - content and context	Rivalry, mistrust, and accord Leaders and nations Cold War crises			

Figure 28: VCE history content visualiser

Empires	**Units 1 and 2: Empires**	**Area of Study 1: The rise of empires**
		Area of Study 2: Encounters, challenge and change
Modern History	**Unit 1: Change and conflict**	**Area of Study 1: Ideology and conflict**
		Area of Study 2: Social and cultural change
	Unit 2: The changing world order	**Area of Study 1: Causes, course and consequences of the Cold War**
		Area of Study 2: Challenge and change
Ancient History	**Unit 1: Ancient Mesopotamia**	**Area of Study 1: Discovering civilisation**
		Area of Study 2: Ancient empires
	Unit 2: Ancient Egypt	**Area of Study 1: Egypt: The double crown**
		Area of Study 2: Middle Kingdom Egypt: Power and propaganda
	Unit 2: Early China	**Area of Study 1: Ancient China**
		Area of Study 2: The early dynasties
	Units 3 and 4: Ancient history	**Area of Study 1: Living in and ancient society:** - Ancient Egypt (1550–1069 BCE) - Ancient Greece (800–454 BCE) - Ancient Rome (c.753–146 BCE)
		Area of Study 2: People in power, societies in crisis - Ancient Egypt–The Amarna Period (1391–1292 BCE) - Ancient Greece–The Peloponnesian War (460–404 BCE) - Ancient Rome–The fall of the Republic (133–23 BCE)
Australian History	**Units 3 and 4: Australian history**	**Area of Study 1: Foundations** - From custodianship to the Anthropocene (60,000 BCE–1901) - Creating a nation (1834–1913) - Power and resistance (1788–1913) - War and upheaval (1909–1950)
		Area of Study 2: Transformations - From custodianship to the Anthropocene (1950–2010) - Creating a nation (1945–2008) - Power and resistance (1957–1998) - War and upheaval (1950–1992).

Revolutions	**Units 3 and 4: Revolutions**	**Area of Study 1: Causes of revolution** - The American Revolution (1754–4 July 1776) - The French Revolution (1774–4 August 1789) - The Russian Revolution (1896– 26 October 1917) - The Chinese Revolution (1912–1 October 1949).
		Area of Study 2: Consequences of revolution - The American Revolution (4 July 1776–1789) - The French Revolution (5 August 1789–1795) - The Russian Revolution (26 October 1917–1927) - The Chinese Revolution (October 1949–1976).

Structure

DP history SL is structured around prescribed subjects, world history topics, and the internal assessment. Teachers select what options to offer to students. SL students take one of the five prescribed subjects, two of the 12 world history topics, and then choose any historical topic for their internal assessment investigation. DP history HL is identical in structure to SL except students are required to also take one of the four HL regional options and study three of the 18 possible sections within that regional option. Both SL and HL students, therefore, spend 40 teaching hours on a prescribed subject, 90 teaching hours combined on two world history options, and 20 teaching hours on the internal assessment. HL students spend an additional 90 teaching hours on their HL regional option depth studies.

VCE history does not have a SL/HL division. All students take a four-unit pathway from a list of 13 possible units. For Units 1 and 2, students can study 'Empires', 'Modern History' (Unit 1: Change and Conflict and Unit 2: The Changing World Order) or 'Ancient History' (Unit 1: Ancient Mesopotamia and Unit 2: Ancient Egypt or Early China). For Units 3 and 4, students can study 'Ancient History', 'Australian History', or 'Revolutions'. Each Unit is subdivided into further Areas of Study, Outcomes, and Key Knowledge. Each Unit involves at least 50 hours of scheduled classroom instruction.

Key similarities between VCE and DP history are that both are designed around flexible pathways through options which cover different periods of time and different geographic areas. The number of available options is certainly greater within DP history; however, both have content options that the other does not. Both VCE and DP SL/HL will expose students to roughly four different broad topics over the course of two years and both would also guarantee (through their structures) that students are exposed to either more than one period of history or more than one area/field of history. VCE history does not have the same level of topic flexibility provided by the DP's internal assessment investigation.

Content Alignment

It can be complex to compare the history curricula of two different programmes, as the levels of optionality available mean that what may appear as significant divergence on paper could be considerably less divergent in practice, depending on the options selected by students/teachers. As a result, Ecctis' analysis of subject alignment considered both the specific historical content of sub-topics, such as time and place, and the conceptual aspect of topics – what are the themes that emerge and what historical approaches are deployed? This dual perspective gives a more accurate overall picture of subject content alignment.

There are some DP history sub-topics which are not covered within VCE history. These are generally quite specific areas such as 'Genghis Khan', 'Richard I', 'Muslim Rule in Spain', 'Conquest of Mexico and Peru', and 'Origins, Development and Impact of Industrialization'. These areas of zero coverage in the VCE are far less common, however, than areas of partial coverage. Over a third of DP history sub-topics have partial coverage in the VCE curriculum. In many cases, this partial judgement is because relevant historical themes are shared, even if the VCE does not cover precisely the same events, people, or geography. There are also many DP sub-topics which have been judged to clearly align with a part of the VCE history curriculum. This does not mean that all precise questions and discussion points are identical, but that the broad themes, content, and context are shared.

It is interesting to note that the Medieval period is generally not present in the VCE curriculum, and the early modern period is only featured sparingly. DP history, on the other hand, features a wide range of topics throughout both periods. On the other hand, the VCE curriculum features 'Ancient History' unit options for Units 1, 2, 3, and 4 – meaning that students can focus on this period throughout their two years of study. DP history does not feature any sub-topics before the year 750AD.

To complement the analysis on content alignment, the figure below represents a simplified summary of the VCE's content alignment, at topic-level, with DP history (SL and HL).

Figure 29: Summary of content alignment between the DP history topics and the VCE's history curriculum

DP history topics	Presence in VCE history
Prescribed subjects: Military leaders	
Prescribed subjects: Conquest and its impact	
Prescribed subjects: The move to global war	
Prescribed subjects: Rights and protests	
Prescribed subjects: Conflict and intervention	
World history topics: Society and economy (750-1400)	
World history topics: Causes and effects of wars (750-1500)	
World history topics: Dynasties and rulers (750-1500)	
World history topics: Societies in transition (1400-1700)	
World history topics: Early Modern states (1450-1789)	
World history topics: Causes and effects of Early Modern wars (1500-1750)	
World history topics: Origins, development and impact of industrialization (1750-2005)	
World history topics: Independence movements (1800-2000)	
World history topics: Emergence and development of democratic states (1848-2000)	
World history topics: Authoritarian states (20th century)	
World history topics: Causes and effects of 20th-century wars	
World history topics: The Cold War: Superpower tensions and rivalries (20th century)	
HL depth studies: History of Africa and the Middle East	
HL depth studies: History of the Americas	
HL depth studies: History of Asia and Oceania	
HL depth studies: History of Europe	
Internal investigation	

Key:

	Strong presence of this topic in the VCE		*Partial presence of this topic in the VCE*		*Little or no presence of this topic in the VCE*

Overall, the levels of breadth and depth that students will be exposed to are similar in both history curricula. Social, cultural, military, political, and economic history feature in both and students are frequently asked to look at broad themes and developments while also narrowing their focus to individual actors or significant events. From the specifications reviewed by Ecctis, the DP internal assessment may offer an opportunity for personalised research to a deeper degree than the VCE course, however, there are also flexible opportunities for 'a historical inquiry' in VCE school-based coursework, so the implementation of this may provide something comparable to the DP's internal assessment.

Depending on the specific pathways chosen by DP history teachers, it is possible that DP students will have a curriculum experience that is focussed on depth within a certain time, place or theme. For example, the DP history subject guide indicates that a potential HL student pathway which focusses on medieval Islamic history could include:

- Prescribed subject: Military leaders (Genghis Khan and Richard I)
- World history topics: Society and economy (750-1400) and Dynasties and rulers (750-1500)
- HL option: History of Africa and the Middle East - The Abbasid dynasty (750–1258); The Fatimids (909–1171); The Crusades (1095–1291).
- Internal assessment: Student chooses any historical topic to investigate, for example, economic change under the Umayyad Caliphate.

Through a pathway such as this, DP history HL students will experience a broad range of types of history – military, study of political leaders, social, economic, and political – but with a focus on gaining expertise and depth of understanding within a particular period (Medieval) and encircling a broad theme (Islamic history). Though VCE history units also enable a specialised pathway, students would likely experience a wider thematic and chronological breadth than the DP example above. However, as stated above, it is also possible for a DP student to have a far more diverse chronological and thematic experience through the selection of different options. Overall, we can conclude that the DP has scope for greater depth rather than breadth, but that will not be the experience of all students.

In terms of depth, both programmes' history curricula give students the opportunity to explore detailed case studies within broader learning areas. The HL options in the DP involve a very close look at specific events/themes within the chosen region. Similarly, there are sub-topics within VCE units that involve giving precise attention to the micro and the macro level simultaneously.

In terms of breadth, the DP history curriculum is clearly global in its scope, covering a very wide array of areas and topics after 750 AD. However, it is important to note that students will experience a curated selection of these topics, rather than learning about history from all regions and all periods. The VCE curriculum includes little on the Medieval and Early Modern periods but does have strong coverage of Ancient History topics. Students in both programmes, who study history, will learn about history from more than one region. Both also ensure that students are exposed to military, political, social, cultural, and economic history, with internal assessment options that offer the chance for specialisation.

Table 26: VCE history content that is not covered by DP history

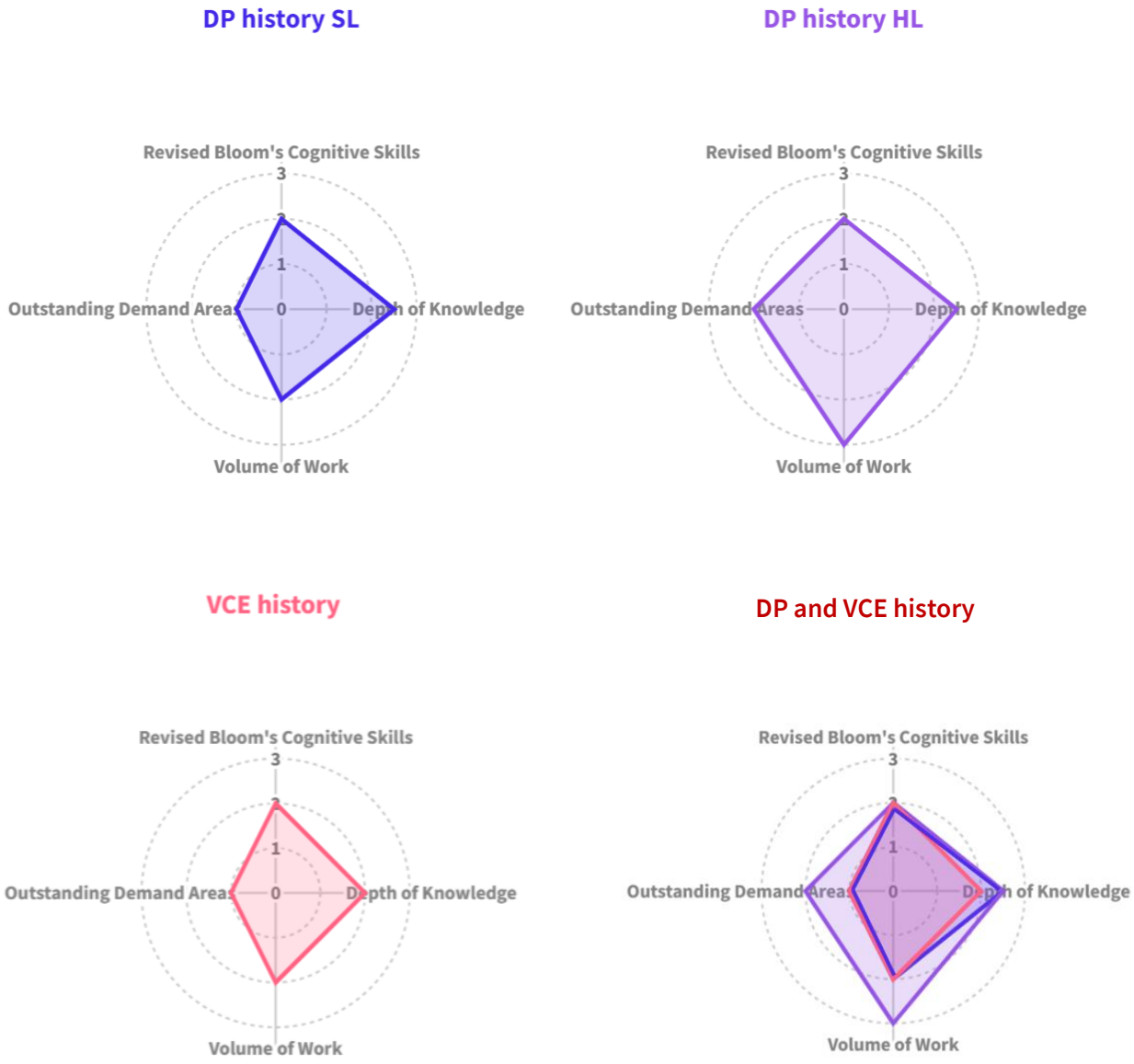
Significant VCE history content which is not included in DP history

• DP students will encounter similar themes, concepts, and approaches to history but will not experience the specific geographical/chronological context of the following topics:
  ○ Ancient History, including:
  ▪ Ancient Mesopotamia
  ▪ Ancient Egypt
  ▪ Early China
  ▪ Ancient Greece
  ▪ Ancient Rome
  ○ Certain topics within Australian History

5.5.3 Demand – History

The DP and VCE history curricula were analysed using the same demand tool in order to create a demand profile for DP history SL, DP history HL, and VCE history. 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 30: Visual representations of subject demand



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 history has the same learning outcomes for both SL and HL, meaning that these scores are the same. Both the DP and VCE curricula were judged to show

some presence of evaluation and synthesis, but with the majority of learning outcomes focused on a combination of analysis, application, knowledge and understanding. A score of 2 was provided to all.

- Regarding the score for **Depth of Knowledge**:
  - Both the DP history SL and HL were judged to merit a score of 2.5. Assessment Objectives 3 and 4, and history Aims 8, 10 and 12 were judged to show evidence that students would be required to develop joined-up and strategic thinking around methods, sources and theories in many contexts. In terms of assessment, the Internal Investigation was judged to be the most important piece of evidence that students would carry out in augmentation, particularly through the requirement to design their own questions and reflect on their work.
  - Indeed, VCE history showed a similar emphasis on strategic thinking, but there is not enough evidence that internal assessment methods stretch students to the same degree of extended thinking as required in the DP's Internal Investigation. The VCE score was therefore capped at 2, though with an acknowledgement that school-based assessment methods are flexible in that course and could be used to push students towards augmentation.

- Regarding the scores for **Volume of Work**:
  - DP history SL was judged to comprise moderate-heavy workload (a score of 2) as students will be exposed to multiple types of history, across multiple regions, often going beyond basic conceptual depth in each topic, and carrying out an internal investigation.
  - VCE history was given the same score of 2 as, in Units 3 and 4 in particular, the proportion of time spent on complex issues was judged to be significant and the number of sub-topics is substantial throughout. DP history HL was judged to have a higher volume of work demand score (3), as the HL regional depth studies comprise significant and complex work. Despite an extra 90 teaching hours being devoted to this, the detail involved in these topics was judged to push the volume of work score into the heavy category.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - The internal investigation and the fact that students are exposed to so many forms of history were judged to comprise stretch components of DP history SL – resulting in a score of 1 – while the regional expertise developed through the HL regional options caused the HL score to exceed the SL on this measure – reaching a score of 2.
  - The breadth of types of history included in the VCE was also judged to comprise outstanding demand – resulting in a score of 1.

6. Key Findings

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

6.1 Programme Level

Philosophical Underpinnings
The philosophical underpinnings of the DP and the VCE are **highly aligned**.

The majority of key themes within the IB's learner profile, approaches to teaching and learning, and philosophy of international-mindedness are present to at least some extent in the VCE Curriculum Design Principles, with the most significant absence being the 'Communicative and collaborative competence' theme. Although some differences are found in degree of emphasis on specific issues, students or teachers moving between the programmes would find a high level of consistency between the two.

Programme Structure
The broad programme structures of the DP and the VCE are **highly aligned**.

There are multiple key similarities between the two programme structures; for example, both have a two-year duration, with subjects typically being studied over two years, and both target completion of an overarching diploma while also providing subject-specific grades. Moreover, the VCE's 16 to 24-credit structure typically leads to students experiencing between four and six subjects in total – a smaller or equivalent number to the DP's six.

However, there are also some structural dissimilarities. While the DP takes a baccalaureate-style approach to encouraging breadth of study, the VCE is more flexible – students can either follow a similar baccalaureate-style approach and study subjects from different subject groups, or a more specialised path by, for example, choosing to study three or four science subjects (see Student Learning Pathways below). Moreover, whereas the DP differentiates subjects as either SL or HL, VCE subjects do not make such a distinction.

Nevertheless, despite some differences in subject selection flexibility, there is a high level of overall structural alignment between the two programmes.

Entry Requirements
The entry requirements of the DP and the VCE are **moderately aligned**.

Both the DP and the VCE present a flexible approach to entry requirements at the start of their programmes. The DP 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 for the VCE, though, in some studies, students are advised to complete either or both Units 1 and 2 before attempting Unit 3 (or have equivalent experience). The subject-specific entry requirements in the VCE are therefore cumulative across the two years

of the course, whereas the DP is highly flexible but generally fixes students into their subject choices for the whole two-year duration.

Student Learning Pathways
The student learning pathways in the DP and the VCE are **moderately aligned**.

Both programmes provide a significant level of optionality in relation to subjects studied. However, the approach to combining subject-specialisation with breadth can be quite different: while the DP typically requires that students study one subject per every subject group, the VCE's only requirement is that students study three units from the English group, allowing them to pick their other subjects regardless of the subject group these belong to. As a result, the degree of specialisation allowed in the VCE is higher, with students being able to trade breadth in favour of specialisation in one particular area (e.g. science) if they so wish, but also being able to pursue a baccalaureate-style approach if it suits their interests.

In summary, while both programmes enable students to pursue subjects that interest them to a higher level than subjects which are less significant to their intended pathway, the degree to which this is allowed differs, with the DP emphasising breadth and the VCE allowing more flexibility regarding specialisation.

Assessment Methods
The overarching approaches to assessment in the DP and the VCE are **highly aligned**.

Both the DP and the VCE use external terminal assessment to make up the majority of assessment in each individual subject (between 75-80% for DP subjects and 50-66% for VCE subjects). Although internal assessment is given greater weighting in the VCE (between 34%-50%) than in the DP (between 20-25%), the methods of assessment are broadly aligned and similarly prioritise the development of higher-order thinking skills.

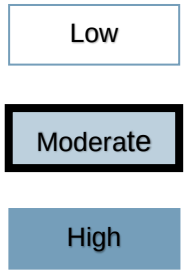
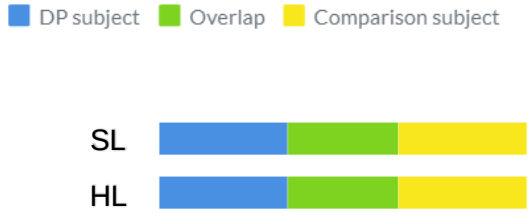
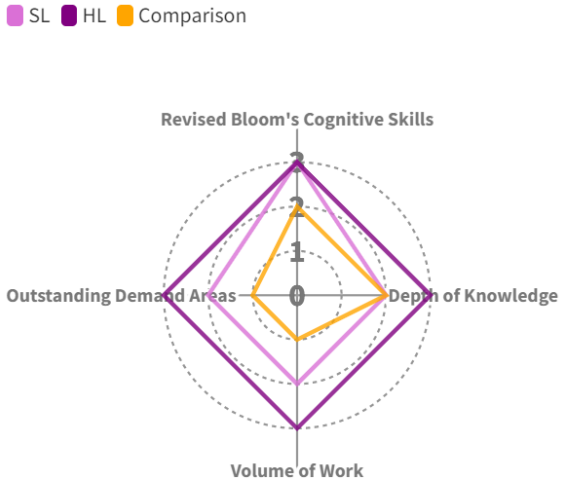
Summary
Overall, Ecctis has judged the programme-level features of the DP and VCE to be **highly aligned**.

The student learning pathways allowed by the two programmes are the most significant point of difference and the assessment the most significant point of similarity. In all other respects, there are some notable differences, though with points of considerable alignment with regards to how students likely 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 VCE. The summaries include key findings on learning outcomes alignment, content alignment and demand alignment, as per the key below:

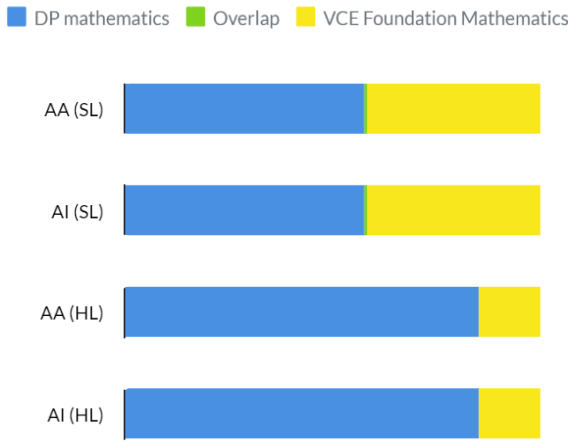
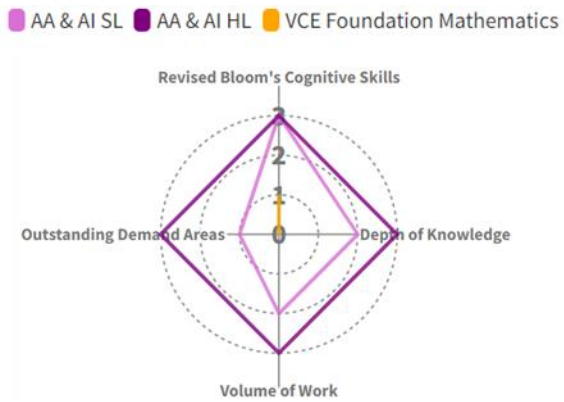
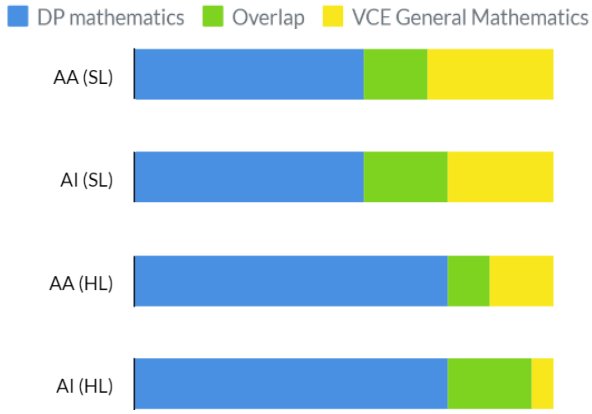
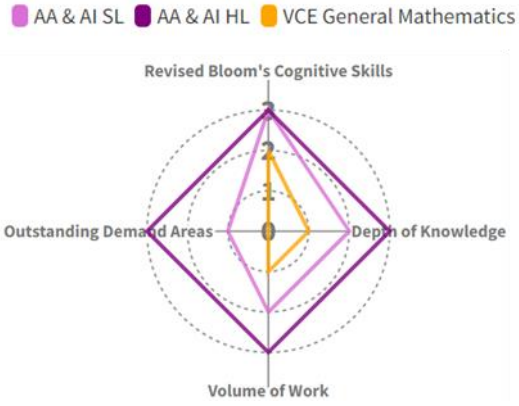
Key:

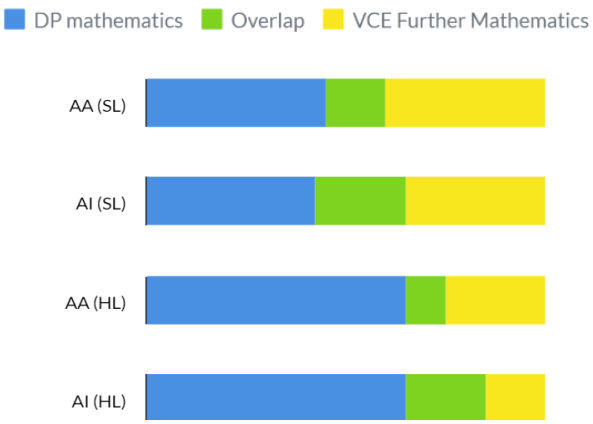
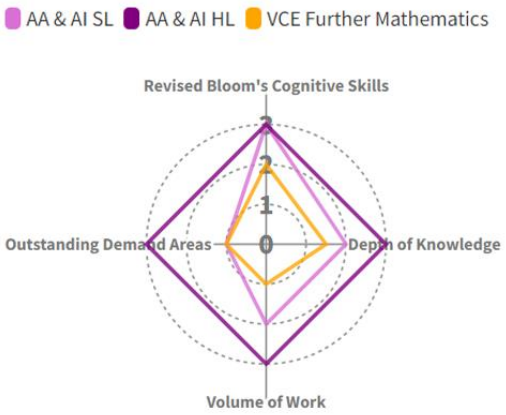
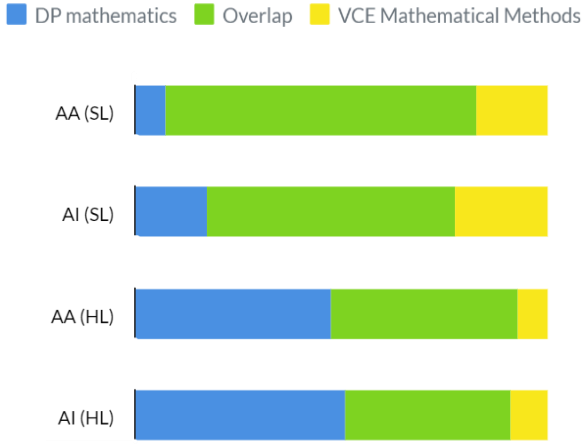
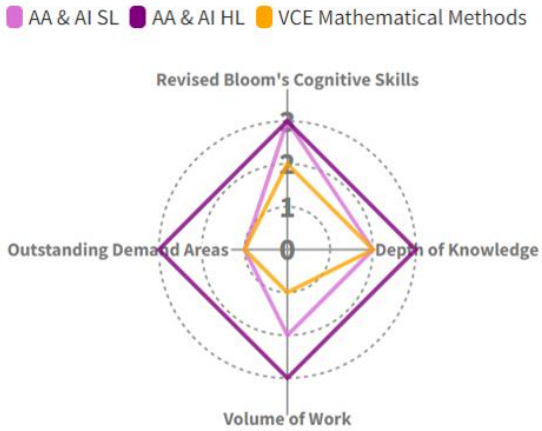
Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Displays the name of the comparison subject	 This represents the learning outcome alignment between the DP subject and the comparison subject. A black border is placed around the selected judgement – 'Moderate' in this example.	 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 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.

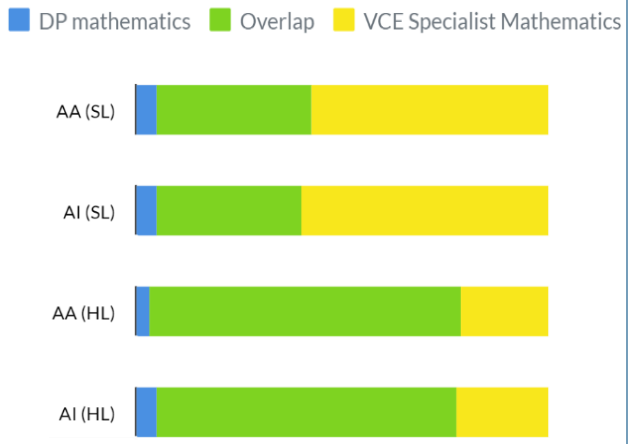
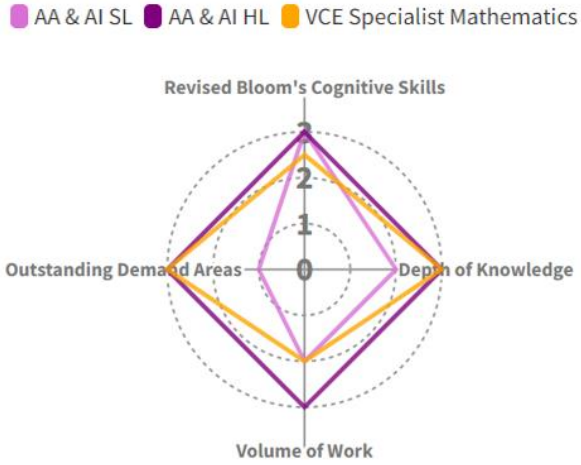
6.2.1 Mathematics Alignment

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

Figure 31: Visual representations of subject-level alignment (mathematics subjects)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Foundation Mathematics (FM)	Low Moderate High		
General Mathematics (GM)	Low Moderate High		

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Further Mathematics (FRM)	Low Moderate High		
Mathematical Methods (MM)	Low Moderate High		

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Specialist Mathematics (SM)	Low **Moderate** High		

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the VCE units' learning outcomes is varied. For Foundation Mathematics, General Mathematics, and Further Mathematics the alignment was low, increasing to moderate for Mathematical Methods and Specialist Mathematics. No courses are considered to have high alignment with the DP's learning outcomes.

- **Content alignment**: the level of content alignment between DP mathematics subjects and VCE mathematics subjects varied. Greater overlap is found with courses offering Units 3 & 4 than with those offering Units 1 & 2 only, namely Foundation Mathematics and General Mathematics. Further Mathematics, though offering Units 3 & 4, also has limited alignment with DP subjects, though slightly more with AI than AA, due to its applied nature. Mathematical Methods has strong alignment with DP SL content, especially AA, though limited overlap with DP HL, which exceeds Mathematical Methods content in breadth and depth. Finally, Specialist Mathematics has significant overlap with both HL subjects, also including more additional content than the DP subjects.

- **Demand alignment**: with the exception of Specialist Mathematics, all VCE subjects are surpassed by the demand of DP SL mathematics. Foundation Mathematics and General Mathematics score considerably lower in all categories, whilst Further Mathematics and Mathematical Methods both score lower for volume of work and cognitive skills but are generally more comparable to SL. DP HL considerably surpasses in demand all subjects except Specialist Mathematics, which is more comparable due to scoring the same, or similar, in all categories except volume of work.

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

- **Similarities in learning outcomes:** there are some overlaps in the learning outcomes of DP and VCE mathematics subjects. Out of the eight learning outcome themes extracted from the DP mathematics subject group, five are present in Foundation Mathematics and six are present for all other VCE subjects. The strongest similarities identified are themes of understanding mathematical concepts, applying critical thinking skills in analysis and problem-solving, using investigative skills, and the emphasis on the use of technology. Specialist Mathematics has the strongest similarity with DP outcomes, as it includes more focus on reasoning and making generalisations, closely followed by Mathematical Methods.

- **Similarities in content:** the level of similarity with DP content varies significantly. The courses most closely aligned to DP subjects are Mathematical Methods and Specialist Mathematics. Mathematical Methods has strong similarities with DP SL mathematics content, particularly AA. Mathematical Methods covers a similar range of topics and most of its content is present in the DP. Therefore, the breadth and depth of Mathematical Methods is comparable to DP SL. Specialist Mathematics has strong similarities with DP HL mathematics content, as it covers a considerable amount of AHL sub-topics found in both AA and AI. Therefore, Specialist Mathematics is comparable to DP HL for content depth.

- **Similarities in demand**: Mathematical Methods is strongly aligned with DP SL mathematics subjects with regards to demand – scoring similarly in most categories, especially for depth of knowledge. Further Mathematics is less aligned with DP SL mathematics subjects but has some similarities – scoring similarly in most categories, especially for outstanding areas of demand. Specialist Mathematics is the only subject with strong alignment with the demand of DP HL mathematics subjects and scores very similarly, especially in the categories of depth of knowledge and outstanding areas of demand.

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

- **Differences in learning outcomes**: in contrast to the DP mathematics curricula, VCE sets out specific outcomes for all its units, as well as having a small number of ‘aims’ which are applicable to all. Not all extracted DP themes are present, as VCE mathematics outcomes do not focus on wider contexts of mathematics or transferable learning skills. Furthermore, DP themes which are present are often not emphasised or described in similar ways to the DP. Generally lacking in comparable emphasis are:

reasoning, using generalisation, making links, and communicating in various forms. Though references to these skills are made in the VCE learning outcomes, they are often very specific in nature, rather than being presented as general expectations to be continually developed.

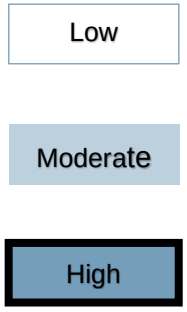
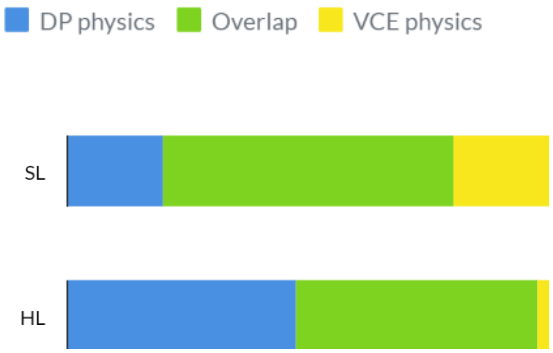
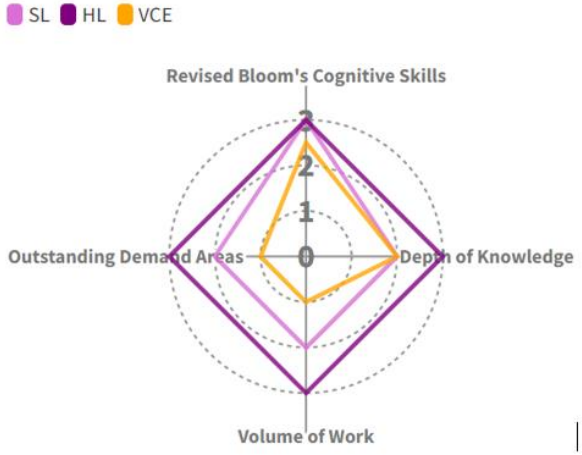
- **Differences in content:** There are some structural differences between DP and VCE mathematics subjects. Most significantly, General Mathematics and Specialist Mathematics (Units 1 & 2) have optional content and thus have an element of flexibility not present in DP mathematics. Furthermore, whilst both DP and VCE curricula cater for more advanced mathematical study, VCE also offers a more basic mathematics subject in the form of Foundation Mathematics. Moreover, VCE mathematics also offers a more strongly applied-focused subject in the form of Further Mathematics, which focuses largely on statistics and finance. In terms of content alignment, Foundation Mathematics has no alignment with DP mathematics content as it generally covers less-demanding concepts. General Mathematics and Further Mathematics contain a small number of sub-topics comparable to elements of the DP curricula, though they generally have limited or no alignment with the main topics in the DP. Finally, Specialist Mathematics covers nearly all DP HL content, though differs by including additional content, such as topics that are only present in one of AA or AI, and topics which are in neither, for example, content involving mechanics and logic.

- **Differences in demand:** all VCE subjects do not score as highly as the DP for presence of higher order cognitive skills. Indeed, Foundation Mathematics scores significantly less than DP SL and HL subjects in all demand categories. Furthermore, with the exception of Specialist Mathematics, no other subject in VCE mathematics has similarity in demand to DP HL, particularly in the categories of volume of work and outstanding areas of demand.

6.2.2 Physics Alignment

The subject level alignment between the DP and VCE physics subjects is represented below:

Figure 32: Visual representations of subject-level alignment (physics subjects)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Physics			

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and VCE physics is significant, with most themes extracted from the DP learning outcomes being present in the VCE's learning outcomes. Indeed, the learning outcomes of VCE physics similarly focus on developing skills of scientific inquiry, technological skills, application, creative and critical thinking, awareness of global issues, environmental and societal implications. However, development of conceptual understanding is only an implicit theme in the learning outcomes of VCE physics, rather than explicit.

- **Content alignment**: there is significant topic and sub-topic overlap between VCE and DP physics, with VCE physics covering a significant proportion of SL content as well as some HL-only sub-topics that are not present in SL. The DP physics HL, on the other hand, contains a substantial amount of unique content that is not present in the VCE.

- **Demand alignment**: the demand of the VCE physics course is closer to DP physics SL, though the latter scored higher for volume of work and number of stretch areas. The DP HL course scores significantly higher than VCE physics, particularly for depth of knowledge, volume of work, and stretch areas.

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

- **Similarities in learning outcomes:** the learning outcome themes extracted from DP physics are strongly present in VCE physics, with the exception of conceptual understanding and making connections, which was found to be implicitly present, rather than explicitly. There is also a high degree of alignment regarding the emphasis given to each of the themes – VCE similarly emphasises application of skills and knowledge, scientific inquiry, creative and critical thinking, development of technological skills, awareness of global issues and environmental and societal implications, and communication and collaboration skills.

- **Similarities in content:** there is considerable overlap between the VCE physics and the DP SL content, as VCE includes content from all the main topics, particularly 'Space, time, and motion' and 'Fields'. Furthermore, with regards to HL content, VCE physics partially aligns with each main topic, except for 'The particulate nature of matter'. Practical activities, individual investigation and project work are also covered in both the DP and VCE content throughout the course of study.

- **Similarities in demand:** from a demand perspective, the VCE physics curriculum is closer to the DP physics SL course than the DP physics HL course, with the demand level of the HL being significantly higher. In particular, the VCE physics scores for Bloom's cognitive skills and depth of knowledge are deemed to broadly align with DP SL.

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

- **Differences in learning outcomes:** there are only a few differences of note. Firstly, VCE physics has less focus than the DP on conceptual understanding, as this is implied through other expectations rather than explicitly stated. Also, VCE physics includes statements about the types of attitudes and values it aims to develop within students during their studies of physics, which are reflected in the IB learner profile rather than the DP's specific aims for the sciences subject group.

- **Differences in content:** there are some differences between DP physics and VCE physics in relation to the level of detail and choice of coverage within the main topic areas. Most topics, for both SL and HL, are only partially covered by VCE physics. For SL, the main topics which are partially covered are 'The particulate nature of matter', 'Wave behaviour', and 'Nuclear and quantum physics'. Instead of covering all the SL sub-topics in these main areas, VCE physics includes sub-topics which are AHL content in the DP. However, a substantial amount of AHL content is covered in lesser detail or not present. Such AHL sub-topics include thermodynamics, simple harmonic motion, rigid body mechanics, the Doppler effect, and structure of the atom. Therefore,

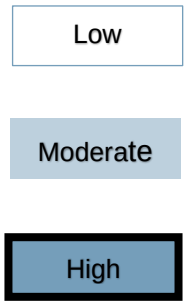
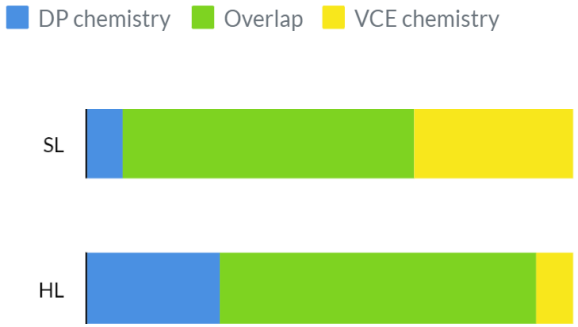
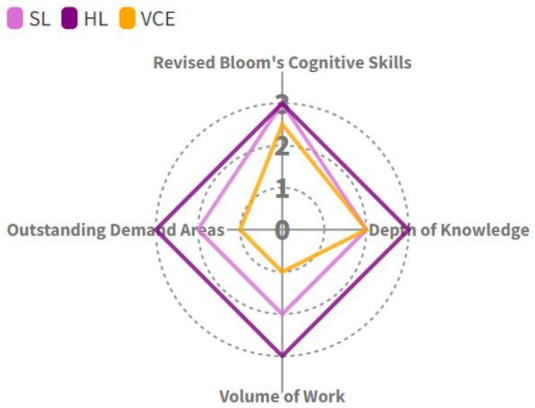
VCE physics has considerably less depth and breadth than DP HL physics. There are also structural dissimilarities. For example, where AHL content in the DP HL typically builds on SL content, in the VCE there is less progression in terms of content between units, with no prerequisite content from Unit 1 being required to take Units 2 and 3.

- **Differences in demand:** from a demand perspective, the VCE physics curriculum is closer to the DP physics SL course than the DP physics HL course, with the demand level of the HL being significantly higher. This is mainly due to the volume of work and outstanding demand areas scores – the DP physics HL has significantly higher workload and number of stretch areas than VCE physics.

6.2.3 Chemistry Alignment

The subject level alignment between the DP and VCE chemistry subjects is represented below:

Figure 33: *Visual representations of subject-level alignment (chemistry subjects)*

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Chemistry			

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and VCE chemistry is high, with most themes extracted from the DP learning outcomes being present in the VCE's learning outcomes. Indeed, the learning outcomes of VCE chemistry similarly focus on developing skills of scientific inquiry, technological skills, application, creative and critical thinking, awareness of global issues, environmental and societal implications. However, development of conceptual understanding is only an implicit theme in the learning outcomes of VCE chemistry, rather than explicit.

- **Content alignment**: there is significant content overlap between VCE and DP chemistry, for both SL and HL. Compared to SL, VCE chemistry covers a higher number of sub-topics, as it includes some content found in the DP chemistry HL but not in the SL, as well as additional sub-topics unique to VCE chemistry (i.e. not found in either the DP HL or SL). Conversely, the DP chemistry HL as a whole

features more content than the VCE, as it includes a high proportion of HL-only content that is not present in the latter.

- **Demand alignment**: the VCE chemistry course is closer to the DP SL in demand level, though the latter scores higher for volume of work and number of stretch areas. The DP HL course scores significantly higher than VCE chemistry, scoring higher for depth of knowledge, volume of work, and stretch areas

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

- **Similarities in learning outcomes:** the learning outcome themes extracted from DP chemistry are strongly present in VCE chemistry, with exception of conceptual understanding and making connections which is implicitly present, rather than explicitly. There is also a high degree of alignment regarding the emphasis given to each of these themes – VCE similarly emphasises application of skills and knowledge, scientific inquiry, creative and critical thinking, development of technological skills, awareness of global issues and environmental and societal implications, and communication and collaboration skills.

- **Similarities in content:** the majority of DP SL chemistry topic areas are covered in VCE chemistry, with shared coverage being especially evident in relation to the topics within 'Structures' content. Such topics include all those in 'Structure 2. Models of bonding and structure', 'Structure 3. Classification of matter', 'Reactivity 2. How much, how fast, how far?', 'Reactivity 3.1 – Proton transfer reactions', 'Reactivity 3.2 – Electron transfer reactions' and nearly all in 'Reactivity 1. What drives chemical reaction?' and 'Structure 1. Models of the particulate nature of matter'. Therefore, VCE chemistry shares a large proportion of content with DP SL, but somewhat exceeds the latter's depth in certain topics. Moreover, VCE chemistry also covers a few areas of AHL content, mostly within 'Structures', including similar coverage of classification of elements and classification of organic compounds. Practical activities, individual investigation and project work are also covered in both the DP and VCE content throughout the course of study.

- **Similarities in demand:** from a demand perspective, the VCE chemistry curriculum is closer to the DP chemistry SL course than the DP chemistry HL course, with the demand level of the HL being significantly higher. In particular, the VCE chemistry's scores for the Bloom's and depth of knowledge demand categories broadly align with DP SL.

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

- **Differences in learning outcomes:** there are only a few differences of note. Firstly, VCE chemistry has less focus than the DP on conceptual understanding, as this is implied through other expectations rather than explicitly stated. Also, VCE chemistry includes statements about the types of attitudes and values it aims to develop within students during their studies of chemistry, which are reflected in the IB learner profile rather than the DP's specific aims for the sciences subject group.

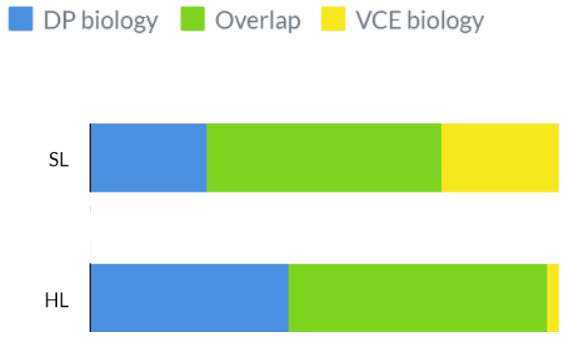
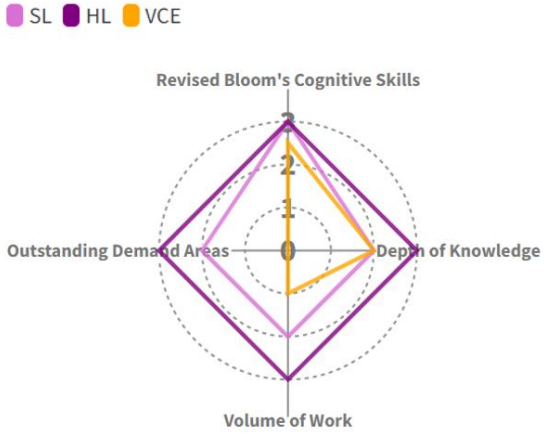
- **Differences in content:** despite VCE chemistry covering most SL content, there is considerably less coverage of AHL content. Indeed, there is mostly no alignment with AHL content in 'Reactivity' topics, such as proton transfer reactions, entropy and spontaneity, energy cycles in reactions, rate of chemical change, and the extent of chemical change. Therefore, VCE chemistry has less depth in certain topics than DP HL. Furthermore, some topics can also be found in the VCE chemistry course which are not present in DP chemistry, including Faraday's law calculations, Carbon 13 nuclear magnetic resonance (NMR), properties and analysis of water, key food molecules, and metabolism in the human body. There are also structural dissimilarities, as where AHL content in the DP HL typically builds on SL content, in the VCE there is less progression in terms of content between units, with no prerequisite content from Unit 1 being required to take Units 2 and 3.

- **Differences in demand:** from a demand perspective, the VCE chemistry curriculum is closer to the DP chemistry SL course than the DP chemistry HL course, with the demand level of the HL being significantly higher. This is mainly due to the volume of work and outstanding demand areas scores – the DP chemistry HL has a significantly higher workload and number of stretch areas when compared to VCE chemistry.

6.2.4 Biology Alignment

The subject level alignment between the DP and VCE biology subjects is represented below:

Figure 34: Visual representations of subject-level alignment (biology subjects)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
Biology			

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and VCE biology was found to be high, with all themes extracted from the DP sciences learning outcomes being present in the VCE's. Indeed, the learning outcomes of VCE biology similarly focus on developing skills of scientific inquiry, technological skills, application, creative and critical thinking, and awareness of global issues and environmental and societal implications. Furthermore, the updated VCE biology curriculum demonstrated the theme of conceptual understanding more strongly than other VCE science curricula.

- **Content alignment**: there is significant content overlap between VCE and DP biology, for both SL and HL. Compared to SL, VCE biology covers a similar number of sub-topics, as there is significant content overlap between them and both contain similar levels of unique content (i.e. content which is present in one course but not in the other). Compared to HL, while VCE biology does cover some HL topics, the latter features substantially more additional content.

- **Demand alignment**: the VCE biology course was found to be closer to the DP biology SL course in demand level, though the latter scored higher for volume of work and number of stretch areas. The DP HL course was found to score significantly higher than VCE biology, specifically for depth of knowledge, volume of work and stretch areas.

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

- **Similarities in learning outcomes:** all the seven general learning outcome themes extracted from DP biology are found to be strongly present in VCE biology. As with physics and chemistry, there is a high degree of alignment regarding the emphasis given to themes – VCE similarly emphasises application of skills and knowledge, scientific inquiry, creative and critical thinking, development of technological skills, awareness of global issues and environmental and societal implications, and communication and collaboration skills. The VCE biology curriculum was also recently updated and now demonstrates a stronger focus on conceptual understanding and making connections – a key element of the DP sciences group.

- **Similarities in content:** VCE biology covers a fair proportion of the DP SL topic areas in biology, especially topics within 'Unity and diversity', such as nucleic acids, conservation of biodiversity, and evolution and speciation. There is also a strong presence of 'Continuity and change' SL content in relation to DNA replication, protein synthesis, cell and nuclear division, water potential, inheritance, homeostasis, and natural selection. In addition, VCE biology also covers some AHL content involving proteins, organelles and compartmentalization, enzymes and metabolism, DNA replication, protein synthesis, nuclear cell and division, and inheritance. Therefore, VCE biology covers some specific areas in similar detail to DP HL.

- **Similarities in demand:** from a demand perspective, the VCE biology curriculum is closer to the DP biology SL course than the DP biology HL course, with the demand level of the HL being higher. In particular, the VCE biology's scores for the Bloom's cognitive skills and depth of knowledge demand categories broadly align with DP SL.

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

- **Differences in learning outcomes:** the only difference of note is that VCE biology includes statements about the types of attitudes and values it expects students to develop during their studies of biology, which are reflected in the IB learner profile rather than the DP's specific aims for the sciences subject group.

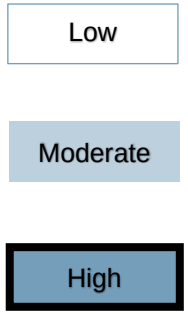
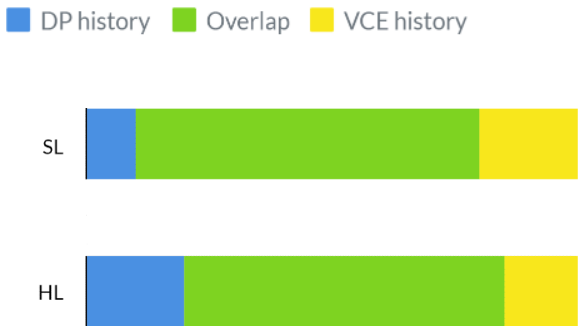
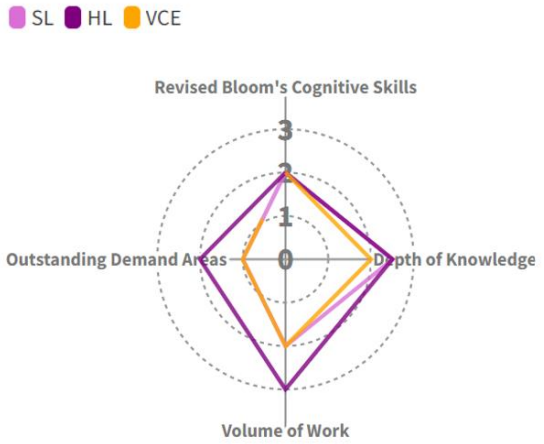
- **Differences in content:** though VCE biology covers both some SL and HL content, there are several topics which are not covered. For SL these include carbohydrates and lipids, transport, ecological niches, neural signalling, transfers of energy and matter, sustainability and change, and climate change. Instead of some SL sub-topic areas, VCE biology includes content which is HL in DP biology. However, a considerable proportion of AHL content is not present or covered in lesser detail, including origins of cells, cell specialisation, chemical signalling, neural signalling, integration of body systems, and all 'B3 Forms and function – organisms' content. Hence, VCE biology has less breadth and depth than DP HL. There are also structural dissimilarities, as where AHL content in the DP HL typically builds on SL content, in the VCE there is less progression in terms of content between units, with no prerequisite content from Unit 1 being required to take Units 2 and 3.

- **Differences in demand:** from a demand perspective, VCE biology is closer to the DP SL than DP HL, with the demand level of the HL being significantly higher. This is mainly due to the volume of work and outstanding demand areas scores – the DP biology HL has a higher workload and number of stretch areas when compared to VCE biology, for which no stretch areas are identified.

6.2.5 History Alignment

The subject level alignment between the DP and VCE history subjects is represented below:

Figure 35: Visual representations of subject-level alignment (history subjects)

Subject name	Learning outcomes alignment	Content alignment	Demand alignment
History			

- **Learning outcomes alignment**: the level of alignment between the learning outcomes of DP and VCE history was found to be high, with all themes extracted from the DP history learning outcomes being present in the VCE's history learning outcomes. Some smaller differences are identifiable at the level of detailed consideration of the practical implications of learning outcomes.

- **Content alignment**: from a thematic perspective, there is substantial overlap in the content covered between VCE history and DP history at both SL and HL. Although each has unique content areas in terms of topics, periods, and regions, the same key approaches and themes are largely shared. There is slightly less overlap between VCE history and DP history HL (compared to SL), as the HL 'Depth studies' options contain more unique content and also reduce the amount of unique VCE content due to the option to study the history of Oceania. This comparison is complex, however, due to both the DP and VCE offering flexible pathways of unit/topic choices to students.

- **Demand alignment**: VCE history has a similar demand profile to DP SL history, though with a slightly lower score for depth of knowledge. DP HL history demand exceeds that of VCE history in all areas except the score for Bloom's Cognitive Skills, which is equal.

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

- **Similarities in learning outcomes:** all six general learning outcome themes extracted from DP history are present to some extent in the VCE. The VCE learning outcomes show a particularly strong coverage of the themes 'Critical study or evaluation of diverse sources' and 'Reflect on the nature of history, including methods and theories'. Both of these themes are present in three of the seven VCE history aims.

- **Similarities in content:** key structural similarities between VCE and DP history are that both are designed around flexible pathways through options which cover different periods of time and different geographic areas. The number of available options is greater within DP history, but both courses have content options that the other does not. Both VCE and DP SL/HL expose students to roughly four different broad topics over the course of two years and both guarantee (through their structures) that students are exposed to either more than one period of history or more than one area/field of history. The levels of breadth and depth that students are exposed to in each course are similar. Social, cultural, military, political, and economic history features in both and students are frequently asked to look at broad themes and developments whilst also narrowing their focus to individual actors or significant events. In many cases, alignment is found due to shared relevant historical themes, not necessarily because the courses cover precisely the same events, people, or geography.

- **Similarities in demand:** from a demand perspective, the VCE history curriculum closely aligns with the DP history SL. Apart from the depth of knowledge score, which is lower for VCE history than the DP history SL, the two courses are comparable across all demand categories considered, namely in their cognitive skills, volume of work and outstanding demand areas scores.

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

- **Differences in learning outcomes:** two elements of the DP's history learning outcome themes are not entirely present in the VCE history aims. Firstly, although the theme 'Metacognition and understanding of the self and the present day' is present to some degree within the VCE learning outcomes, this is only through reference to the present day and not to the self – the VCE aim does not explicitly expect students to understand themselves and their own perspectives by seeing themselves within the present day. Secondly, whilst the DP history theme of 'Reflect on the nature of history, including methods and theories' is included in the VCE history learning outcomes across various different aims, the reference to the reflection upon *theories* is less explicit than in the DP. On the other hand, the VCE learning outcomes are often more explicit than the DP's in terms of the skills that students should develop when studying

the discipline. The way historical reflection is tackled also differs – whereas the VCE learning outcomes contain a sense of focussing on how history impacts politics and political thinking, the DP link between history and the present is more tied to the political self rather than political decisions in the abstract.

- **Differences in content:** there are some DP history sub-topics which are not covered within VCE history. These are generally quite specific areas such as 'Genghis Khan', 'Richard I', 'Muslim Rule in Spain', 'Conquest of Mexico and Peru', and 'Origins, Development and Impact of Industrialization'. Additionally, the Medieval period is generally not present in the VCE curriculum, and the Early Modern period is only featured sparingly, whilst the DP curriculum features a wide range of topics throughout both periods. On the other hand, the VCE curriculum features Ancient History unit options for Units 1, 2, 3, and 4 – meaning that students can focus on this period throughout their two years of study, whereas DP history does not feature any sub-topics before the year 750AD. As with other VCE courses, and contrary to the DP, VCE history does not have a standard/higher level division.

- **Differences in demand:** from a demand perspective, the VCE history curriculum is closer to the DP history SL course than the DP history HL course, with the demand level of the HL being significantly higher. Overall, the DP history HL exceeds the demand of the VCE history course in its depth of knowledge, volume of work, and outstanding demand areas scores.

7. Bibliography

International Baccalaureate. (2014). *Diploma Programme: A guide to assessment*.

International Baccalaureate. (2015). *Diploma Programme: From principles into practice*.

International Baccalaureate. (2015). *History Guide*.

International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*.

International Baccalaureate. (2017). *Assessment principles and practices: Quality assessments in a digital age*.

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

International Baccalaureate. (2019). *Mathematics: analysis and approaches guide.*

International Baccalaureate. (2019). *Mathematics: applications and interpretation guide.*

International Baccalaureate. (2021). *Assessment and Exams*. https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/

International Baccalaureate. (2021). *CAS projects.* https://www.ibo.org/programmes/diploma-programme/curriculum/creativity-activity-and-service/cas-projects/

International Baccalaureate. (2021). *Curriculum*. https://www.ibo.org/programmes/diploma-programme/curriculum/

International Baccalaureate. (2021). *How the Diploma Programme works*. https://www.ibo.org/programmes/diploma-programme/what-is-the-dp/how-the-diploma-programme-works/

International Baccalaureate. (2021). *Theory of knowledge*. https://www.ibo.org/programmes/diploma-programme/curriculum/theory-of-knowledge/

International Baccalaureate. (2021). *Understanding DP assessment*. https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/

International Baccalaureate. (2022). *Diploma Programme*. https://www.ibo.org/programmes/diploma-programme/

International Baccalaureate. (2023). *Biology guide*.

International Baccalaureate. (2023). *Chemistry guide.*

International Baccalaureate. (2023). *Physics guide.*

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

Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Mathematics Study Design.*

Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Physics Study Design*.

Victorian Curriculum and Assessment Authority. (2015). *Victorian Certificate of Education. Chemistry Study Design*.

Victorian Curriculum and Assessment Authority. (2018). *Principles and procedures for the development and review of VCE studies*. https://www.vcaa.vic.edu.au/Documents/vce/Principles_Procedures_VCE_review.docx

Victorian Curriculum and Assessment Authority. (2020). *Victoria Certificate of Education. History Study Design.*

Victorian Curriculum and Assessment Authority. (2020). *Victorian Certificate of Education. Biology Study Design*.

Victorian Curriculum and Assessment Authority. (2022). *VCE Study Designs*. https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/Pages/vce-study-designs.aspx

Victorian Curriculum and Assessment Authority. (n.d.). *How VCE Works – The Facts.* https://www.vcaa.vic.edu.au/studentguides/myvce/Pages/HowVCEWorks.aspx#

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

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

CONFIDENTIAL

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 27: [Subject]

Demand Judgement	Score Descriptors (highlight the best-fit descriptor)	Judgement and Key Evidence
Revised Bloom's Cognitive Skills[88]	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[89]	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	

[88] Evidence pool: Learning outcomes
[89] 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[90]	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[91]	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)	

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